

The AMSAT[®] Journal

ARISSat-1



Editor-in-Chief:
Ed Long, WA4SWJ

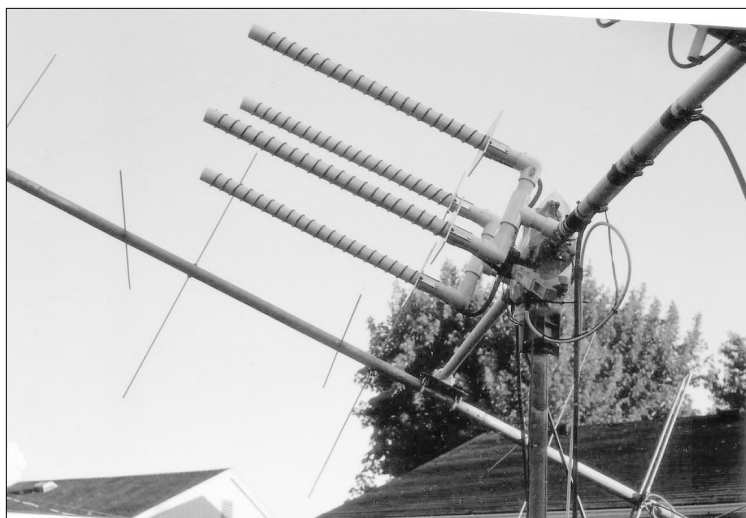
Assistant Editors:
Bill Hook, W3QBC
JoAnne Maenpaa, K9JKM

Volume 34, Number 3

May/June 2011



EME with this? YES!



An Addiction

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AMSAT Announcements

Candidates for the AMSAT Board of Directors:

There are seven candidates running for the Board of Directors. Four of those candidates are members of the Board whose term expires this year. Ballots will be mailed by July 15 and must be received at the Silver Spring, MD office no later than the close of business on September 15, 2011.

Barry A Baines, WD4ASW *

Alan Biddle, WA4SCA *

Steve Coy, K8UD

Drew Glasbrenner, KO4MA *

Mark Hammond, N8MH

Tony Monteiro, AA2TX *

Patrick E Stoddard, WD9EWK



* incumbent

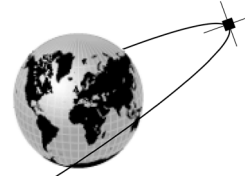
AMSAT's Mission

AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision

Our Vision is to deploy satellite systems with the goal of providing wide-area and continuous coverage. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.





Radio Amateur Satellite Corporation (AMSAT-NA)
850 Sligo Ave., Silver Spring, MD 20910-4703
Telephone: 301-589-6062 – Toll Free: 888-322-6728
Facsimile: 301-608-3410
AMSAT-NA Club Callsign: W3ZM
AMSAT-NA Web site: <http://www.amsat.org>

The AMSAT Journal Staff

Editor-in-Chief: Ed Long, WA4SWJ, wa4swj@amsat.org
Assistant Editor: Bill Hook, W3QBC, w3qbc@amsat.org
Assistant Editor: JoAnne Maenpaa, K9JKM, k9jkm@amsat.org
Circulation: Martha Saragovitz, martha@amsat.org

AMSAT-NA Board of Directors

Barry Baines, WD4ASW, wd4asw@amsat.org
Alan Biddle, WA4SCA, wa4sca@amsat.org
Tom Clark, K3IO, k3io@amsat.org
Drew Glasbrenner, KO4MA, ko4ma@amsat.org
Lou McFadin, W5DID, w5did@amsat.org
Tony Monteiro, AA2TX, aa2tx@amsat.org
Gould Smith, WA4SXM, wa4sxm@amsat.org

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Editorial Office: Ed Long, WA4SWJ, 4420 SE 106TH ST, Belleview, FL, 34420-6835. Please e-mail Journal submissions to: journal@amsat.org.
Editor's telephone: 262-374-1349 (cell). **Advertising Office:** AMSAT-NA Headquarters, 850 Sligo Avenue, Suite 600, Silver Spring, MD 20910-4703. Telephone: 301-589-6062.

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A number of interesting events have taken place over the past few months. I'd like to take a moment to share with you some recent highlights.

H.R. 607

I have previously noted the potential impact of H.R. 607, the "Broadband for First Responders Act of 2011," that was introduced by Rep. Peter King (R-NY), including the potential elimination of the entire 70 cm spectrum allocated for the Amateur Satellite Service, constituting a more significant threat than to terrestrial operations. Almost all current and planned amateur satellites include the use of 70 cm for either uplink or downlink.

Since writing the previous column of "Apogee View", there have been some significant developments. AMSAT Area Coordinator Peter Portanova, WB2OQQ, lives in Rep. King's district and arranged a meeting with his congressman to discuss the impacts of his bill on Amateur Radio. Peter invited three Amateur Radio operators who hold positions with the ARRL in the NY-LI section to the meeting and they discussed the potential impacts on terrestrial operations, including emergency communications. Peter delivered a letter to Rep. King from the President of AMSAT which explains the impact of H.R. 607 on the Amateur Satellite Service, how this bill will adversely impact AMSAT's ability to design and build Amateur Radio satellites. Between the contents of the letter and the conversation that Peter Portanova initiated, the congressman became aware not only of the unintended consequences of his bill, but the unique role of AMSAT as an education and scientific organization over the past 42 years.

Peter's meeting with Rep. King went very well and it resulted in follow-up conversations between Rep. King and Peter on the role of Amateur Radio in space. Rep. King made it clear to Peter Portanova that it was not his intention to adversely impact the Amateur Satellite Service, and he made the commitment to modify his bill to not include the 70cm band as a candidate for auction. Clearly, Mr. Portanova's personal interaction on behalf of AMSAT and Amateur Radio resulted in a significant shift in Mr. King's perspective. This is a great example of an AMSAT member identifying an opportunity where they could help to make a difference and then made it happen. Thank you, Peter!

ITAR

There is an article in this issue of the *Journal* which provides details on a recent AMSAT action to provide comments to the Department of State/Directorate of Defense Trade Controls (DDTC) on a proposed rulemaking involving defense services. A copy of our submission is also included, and this document is also available on the AMSAT Web site. I encourage you to read it since it highlights the continuing challenges that AMSAT faces regarding the sharing of technical information intended to be placed in the public domain.

I want to thank Bill Tynan, W3XO, for his able assistance in working with me on the drafting of AMSAT's submission. As a former president of AMSAT (1991-1998), he is very familiar with ITAR's impact on AMSAT. Bill's input was extremely helpful since he has drafted other AMSAT submissions to governmental agencies (particularly the FCC). Here is another example of a very capable individual stepping forward to help fill a need on no notice and serving as a mentor to the process. Thank you, Bill!

Dayton Hamvention

There is nothing quite like Dayton and this year's edition was a very successful one for AMSAT. The weather was perfect, the attendees enthusiastic and AMSAT was fortunate to enjoy a unique gathering at Hamvention. Despite concerns about the economy and gasoline prices, AMSAT was able to generate about the same amount of revenue and memberships (new and renewing) as in 2010. As in the previous year, there was a matching gift challenge sponsored by the Dayton Amateur Radio Association (DARA). This year's goal is more challenging as DARA is supporting a three for one goal; that is, for every \$3.00 raised by AMSAT, DARA will donate \$1.00 up to a maximum of \$5,000. To date, we've raised a little over one-third of the overall goal. Please consider making a special donation to help us take full advantage of DARA's generosity.

There is a separate article in this issue of the *Journal* on AMSAT at Hamvention, so

continued on page 21 ...



Amateur Radio and Manned Space

by Keith Baker, KB1SF/VA3KSF, kb1sf@amsat.org

(The bulk of this article was previously published as "Manned Space and Amateur Radio" in the May 2010 issue of *Monitoring Times*, Brasstown, NC 28902)

Many readers might be surprised to learn that Amateur Radio's presence in space goes well beyond the Amateur Radio satellites. Amateur Radio has also been an integral part of operations aboard the US Space Shuttle, the Russian MIR Space Station, and more recently, the International Space Station (ISS). In fact, Amateur Radio's presence in various nations' manned space activities now goes back well over 25 years!

The whole idea grew out of the work of some forward thinking Radio Amateur Satellite Corporation (AMSAT) people back in the late 1970s and early 1980s. The first opportunity came when Owen Garrett, W5LFL, was selected to fly on NASA's SKYLAB the USA's first "manned orbital laboratory" that was made out of an old Saturn 5 upper stage. And while a formal request was made to NASA for Owen to carry his Amateur Radio along on that mission, it unfortunately came too late in the planning stages for NASA and others to make the necessary preparations for its use aboard the Skylab.

Some ten years later, and with the

encouragement of several AMSAT people working both in and outside of NASA (along with the good offices of the American Radio Relay League), permission was eventually secured for Owen to operate Amateur Radio during his STS-9 mission aboard the Space Shuttle *Columbia* in the fall of 1983.

And what a success it was! During his 10-day voyage, Owen made contacts with a number of Earth-bound hams from the Shuttle, including a few notables such as Jordan's King Hussein, JY1, and US Senator Barry Goldwater, K7UGA, (both now Silent Keys).

The Birth of SAREX

Needless to say, this activity eventually led NASA to conclude that carrying Amateur Radio aboard the Space Shuttle garnered benefits to both NASA and the Amateur Radio Service, so much so that ham radio equipment eventually became a "frequent flier" on a number of subsequent Space Shuttle missions.

For many years, the Shuttle Amateur Radio Experiment (or SAREX as it came to be known) put school children (and ordinary hams) in direct, "voice-to-voice" contact

with astronauts orbiting the Earth from the Space Shuttle. No doubt, those contacts launched countless careers in science, technology, engineering and math (STEM) from those who participated.

Ham Radio and MIR

But, the idea of carrying along Amateur Radio on space voyages also wasn't lost on other nations, including the Russians orbiting aboard their Russian Space Station MIR. In late 1988, Team Commander Vladimir Titov and Dr. Valeri Poliakov made several contacts with amateurs on the ground from MIR.

The MIR eventually carried a 2m voice transceiver as well as a packet radio transponder and Bulletin Board System (BBS). The packet radio BBS acted much like an early ham radio version of those Internet social networking sites we all now take for granted. At one point, even an amateur Slow Scan Television (SSTV) system was carried aboard the craft. Amateur Radio was in operation aboard MIR for over 10 years, and its ham equipment was used not only by hams from the (then) Soviet Union, but also licensed amateurs from Japan, Great Britain, Austria, France and the USA, all of whom spent various periods of time aboard MIR augmenting the permanent Russian crew.

ARISS Is Born

In late 1986, another meeting organized by Roy Neal, (K6DUE (SK) of NBC-News TV fame), once again brought together representatives of NASA, AMSAT and the American Radio Relay League (ARRL) to consider a program leading to Amateur Radio literally being built into the new International Space Station (ISS) then under development by NASA. The meeting established a formal working group to develop a proposal to be submitted to NASA for Amateur Radio's participation on the ISS. The group known today as the Amateur Radio on the International Space Station (ARISS) committee grew out of those early meetings and has since become the driving force behind keeping Amateur Radio aboard the ISS.

What Is ARISS?

The ARISS project has since evolved into a volunteer program whose principle aim



Photo 1: Long-time AMSAT member and former NASA Astronaut Ron Parise, WA4SIR (SK), makes a SAREX contact during one of his two flights aboard the Space Shuttle "Columbia" in the 1990s. (Courtesy: NASA and AMSAT)





Photo 2: An early NASA promotional poster for the SAREX project. (Courtesy: NASA)

is to inspire students, worldwide, to pursue careers in science, technology, engineering and math by providing Amateur Radio communications opportunities with the International Space Station (ISS) on-orbit crew. Students learn about life on board the ISS and explore Earth from space through their classroom participation in such things as

orbital tracking and radio wave propagation studies to and from space.

Currently, the ARISS working group consists of delegations from 9 different countries including several countries in Europe as well as Japan, Russia, Canada and the USA. Volunteers from the national Amateur Radio organizations of each country run



Photo 3: Former AMSAT VP of Operations Stacey Mills, W4SM, helps students from the Western Albemarle High School in Crozet, Virginia speak with Frank Culbertson, KD5OPQ, during an ARISS school contact in September 2001 (Courtesy: ARISS and NASA)

ARISS Operating Frequencies (Call Sign: NA1SS)

2m Crew Contact (ITU Regions 2 & 3):

Uplink: 144.4900 MHz FM
Downlink: 145.8000 MHz FM

2m Crew Contact (ITU Region 1):

Uplink: 145.2000 MHz FM
Downlink: 145.8000 MHz FM

2m APRS (Worldwide APRS Digipeater):

Simplex: 145.8250 MHz FM
1200 BPS
Downlink: 145.8250 MHz FM
1200 BPS

2m Imaging:

Downlink: 145.8000 MHz SSTV

70Cm/2m FM Voice Repeater (Worldwide):

Uplink: 437.8000 MHz FM
Downlink: 145.8000 MHz FM

the organization in partnership with their respective AMSAT organizations. Since ARISS is international in scope, the team also coordinates locally with their country's space agency (e.g. ESA, NASA, JAXA, CSA, and the Russian Space Agency) as well as through ARISS working group meetings, teleconferences and via electronic mail.

With the able assistance of experienced Amateur Radio volunteers from Amateur Radio clubs as well as coordination with representatives of the ARISS Team, the program puts ISS crewmembers "voice-to-voice" with large audiences in a variety of public forums where students, teachers, parents and communities can learn about space and space technology and ... of course ... Amateur Radio ... first hand.

More information about ARISS (including how and where to request an ARISS school contact) can be found at: <http://www.rac.ca/ariss/>. Also, NASA's "official" Web link to the ARISS project is at: http://www.nasa.gov/mission_pages/station/research/experiments/ARISS.html.

More than School Contacts

Besides interesting students in scientific careers, the ARISS equipment aboard the ISS also provides an emergency backup communications capability for NASA for use when their official communication channels to the ISS go down. While such occurrences are rare, the ARIS equipment

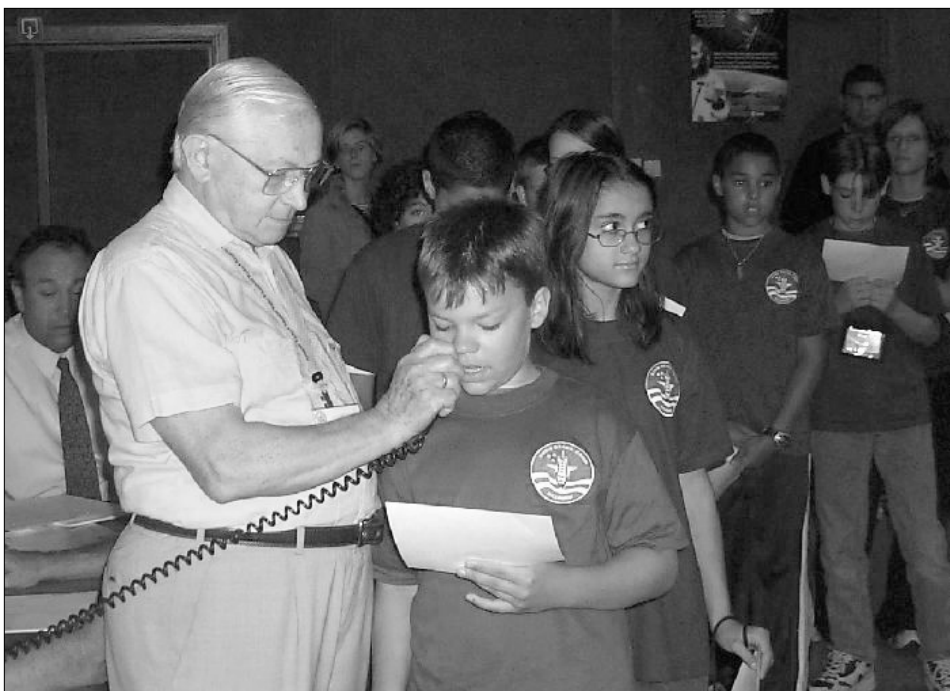


Photo 4: Students attending Space Camp at the Euro Space Center in Belgium gather in their auditorium to speak with Astronaut Ed Lu on board ISS during Expedition 7 in July 2003. (Courtesy: NASA)

aboard the ISS *has* actually been used for this purpose on at least two occasions. What's more, ARISS provides the onboard crew with an unofficial way for them to speak directly with friends and family as well as other Amateur Radio operators on Earth during their off duty time. In many ways, ARISS provides the ISS crew with a great way for them to stay connected with other human beings (besides their crewmates) during their many months of isolation

aboard the ISS. This may also be why nearly 75 percent of NASA astronauts now hold FCC issued Amateur Radio Licenses and why many who have spent long months aboard the ISS have expressed their sincere gratitude for the "morale boost" that use of the ARISS equipment gave them while they were in orbit.

To help earthbound hams get a better idea of what its like to operate via Amateur Radio from orbit, one of AMSAT's project

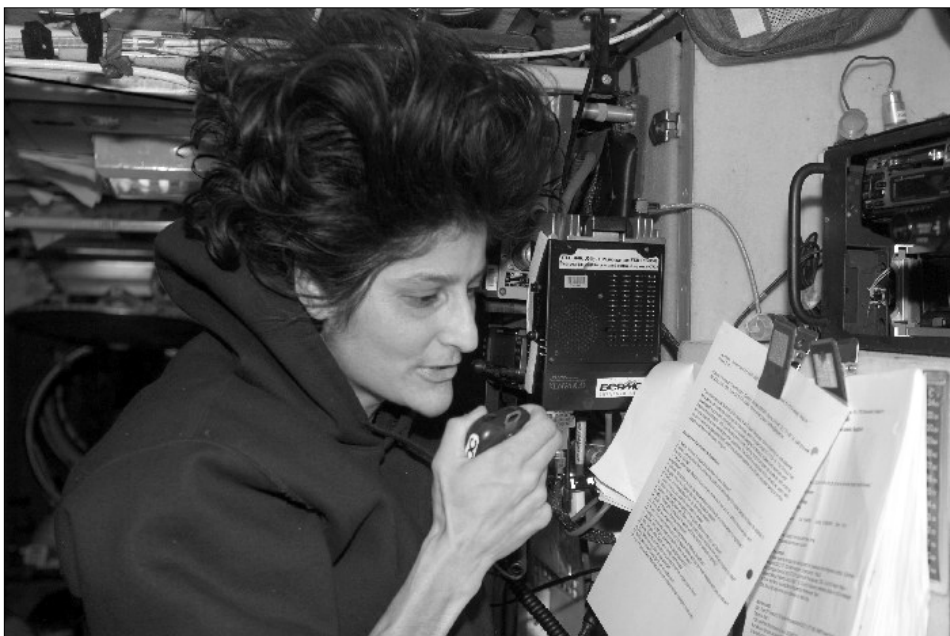


Photo 5: Astronaut Sunita Williams, Expeditions 14 and 15 Flight Engineer, talks with students at the International School of Brussels in Belgium from the ISS's Zvezda Service Module during an ARISS school contact. (Courtesy: NASA)

engineers for ARISS, Ken Ransom, N5VHO, recently posted a fascinating YouTube video from NASA TV on the Internet (<http://www.youtube.com/watch?v=h73EYcysz8>) that shows ISS Expedition 25's Commander Colonel Doug Wheelock, KF5BOC, operating the ARISS equipment from onboard the ISS. After taking viewers on a quick tour of the Space Station, Colonel Wheelock then puts the ARISS ham station on the air during an ISS pass over North America.

What to Listen For

As of this writing, the ARISS equipment aboard the ISS was capable of operating on a variety of frequencies as well as in a number of different modes in the 2m and 70cm amateur bands. Using the ISS's officially assigned FCC call sign NA1SS, these operating modes included FM voice, Slow Scan Television (SSTV), Automatic Packet Reporting System (APRS)[®] tracking and a 70cm to 2m cross-band repeater. While NASA has recently approved the addition of a second ham station aboard the new Columbus module, only one amateur station (currently consisting of a Kenwood D-700 amateur transceiver) is fully operational at this time (see the ISS frequency chart).

When to Listen

It is important to remember that the ISS is in a *very* low Earth orbit. As such, your available "talk time" during an ISS pass from any single location will be noticeably shorter than for most other Amateur Radio satellites. What's more, because the station does a lot of on-orbit maneuvering, having a fresh set of Keplerian Elements loaded into your computer's tracking program is absolutely critical when trying to make contact with the ISS.

Remember, too, that, aside from school contacts, the crew uses the ARISS equipment primarily during their off-duty time and, as such, they may actually be asleep when the ISS passes over your part of the planet. This, in turn, means that making a non-scheduled contact with the ISS crew will usually be a rare treat that is very much subject to the "luck of the draw".

Over the years, I've found the best way to snag a random ISS contact is to program all of the ARISS 2m downlink (and/or uplink) frequencies (plus a few more immediately above and below the published frequencies to account for Doppler shift) into your radio's memory well ahead of time. Then, as the ISS comes over the horizon at your

location, rapidly switching (or scanning) all of these frequencies will quickly tell you which, if any, of the ARISS downlinks are active on the pass.

If you have an Amateur Radio license and want to try and make a contact, once you've found an active ISS frequency and mode, common practice for voice contacts is to *very* quickly drop your call sign into the fray on the uplink after the ISS crewmember completes a CQ call (or finishes another contact).

Because there will most certainly be many other stations calling them (calls that you probably won't hear), keeping your calls short will significantly improve your chances of being heard above the fray on the other end. Unfortunately, the "capture" effect of FM means that the operator aboard the ISS may sometimes only hear "white noise" interspersed with small fragments of call signs, especially during passes over the more populated parts of the planet like North America and Europe.

So, unless you hear the ISS operator answering someone else, keep repeating your call sign over and over again (with frequent breaks) and be ready to repeat your full call sign once again ... or several times ... if asked. On the other hand, if the crewmember answers a call from another station, be courteous and stand by to await your next chance. Eventually, both your courtesy (and your patience!) *will* pay off with a coveted, ISS contact.

Looking Ahead

In future columns, I'll be taking a closer look at the history and operational characteristics of some other Amateur Radio satellites now in orbit along with a peek at some of those now under development. See you then.

REFERENCES

Tynan, William A. (et al.), *AMSAT: The First Forty Years*, Silver Spring, MD: Radio Amateur Satellite Corporation, 2009. 🌐



Photo 6: Colonel Doug Wheelock, Commander of ISS Expedition 25 (shown here in a YouTube video) makes random contacts with Earth-bound hams using the ARISS radio equipment aboard the ISS. (Courtesy: NASA and YouTube)



Photo 7: ARISS contacts forever touch the lives of the school students who make them. Here a young girl goes "voice to voice" with a crewmember onboard the ISS during an ARISS school contact. (Courtesy ARISS and NASA).

Small Payload Rideshare Conference Report

by Tony Monteiro, AA2TX, aa2tx@amsat.org

I recently attended the Small Payload Rideshare Conference held from June 7 to June 9 in Anchorage, Alaska. The sponsors of the conference include the *Office of Space Launch*, which is part of the National Reconnaissance Office (NRO) and the *Launch Services Program* within NASA. The host for this year's conference was the Alaska Aerospace Corporation.

The purpose of the conference is to provide a forum where representatives of government, academia, not-for-profit organizations and the commercial launch services industry can interact and discuss the launch environment for small payloads that are not primary missions. A key driver for this activity has been substantial cost pressure and cuts to DOD and NASA budgets. These agencies are intent on finding new, lower-cost ways to get science and intelligence payloads into orbit. AMSAT is of course also interested in the availability of low-cost paths to orbit and the small satellite launch environment in general. For the purposes of this conference, certain phrases are used to mean very specific things. These are defined in Table 1.

This year there were twenty presentations and panel discussions. Highlights of these are as follows.

1. Colonel Alan Davis, Director, Office of Space Launch, gave the keynote address. He mentioned his sensitivity to the non-classified audience and the need to limit the information presented. But, he specifically discussed the issue of their CHIRP hosted payload package causing a one-year launch delay to its host satellite, the SES-2. This theme was repeated several times by other speakers.

2. Don Hard, retired Major General USAF, chaired a panel discussion on hosted payloads consisting of representatives from Iridium, Space Systems/Loral, SES, and Intelsat. The "Holy Grail" of ridesharing is a government mission flying as a hosted payload on a commercial satellite. This has the most benefit to both the government, since it yields the biggest cost savings, and to the satellite operators and manufacturers since it represents a new source of significant revenue. Unfortunately, experience has shown that a successful hosted payload mission is really difficult to accomplish. In the commercial world, the typical launch campaign is roughly three years and the business cases generally depend on the launch schedule being met. Government missions usually have longer schedules and lower schedule reliability with frequent slips.

This difference in cultures and expectations makes it difficult to match the available excess launch capacity with a government-sponsored payload.

3. Glen Cameron of Orbital Sciences Corp. also discussed CHIRP. Orbital was the manufacturer of the SES-2 commercial satellite that was delayed by the CHIRP payload. Although the launch delay was unwelcome, the hosted payload ended up costing the NRO about \$65M versus an estimated \$500M to fly the mission as a "free-flyer" and overall, this was considered a hosted-payload success story. Glen also discussed the upcoming Cygnus spacecraft that is intended for ISS supply missions. They plan to offer hosted payloads on Cygnus and expect to be able provide up to 5 years in LEO after completing a supply mission via an on-board propulsion system.

4. Gregory Kehrl of Lockheed Martin gave an update on the Athena program. He specifically stated, "*The laws of physics will not change, launch costs will not go down.*" His main point was that hosted payloads and secondary missions are the only realistic way to get a significantly less expensive ride to orbit. He quoted starting prices for a secondary payload of around \$10M. He stated that this is likely to rise to \$12.5M in the 2014-2015 time frame. He also stated that they are planning to "*fly as many P-PODs as we can*" with starting prices for a 3U of around \$250K for 2013 rising to around \$300K in the 2014 - 2015 time frame. This is the price to the launch integrator and would not include the integration costs or the actual P-POD deployer. He mentioned that these low prices are a competitive response to SpaceX. There were many questions from the audience, mostly regarding CubeSats. Greg said that they expect to fly 8-16, 3U P-PODs per Athena launch and that they are expecting a high demand.

5. Keith Karuntzos from United Launch Alliance (ULA) gave a presentation on their launch capabilities. ULA is a joint venture of Lockheed Martin and Boeing that provides launch services specifically to US government customers. He mentioned that they are planning on significant CubeSat capacity to LEO, MEO and GTO. These launches are only available to the US government but this includes the NASA Launch Initiative program.



Photo 1: Launch Pad 1 Service Structure.

Table 1: Glossary of Terms	
Term	Definition
Hosted Payload	An instrument package that is attached to a satellite and uses the satellite's bus but is not part of the satellite mission. (i.e. a hitchhiker)
Primary Payload	The main reason for a space mission and the spacecraft that defines the characteristics of the launch including the orbit
Rideshare	When multiple spacecraft share the costs of a launch
Secondary Payload	A very small spacecraft, typically 400 pounds or less, that is willing to be deployed into a Primary Payloads orbit
Small Payload	A spacecraft that weighs 5000 pounds or less

6. Steve Skladanek of Lockheed Martin/Commercial Launch Services (CLS) spoke about government payload ride sharing on commercial satellite launches. He specifically discussed the government/commercial schedule differences issue. For a launch in 2013, a hosted payload would already need to be already completed or it could not make the launch schedule. For 2014, the payload would need to be completed by 1Q 2012. This schedule chasm

poses a daunting challenge to the entire hosted payload concept.

7. Linda Herrell of Jet Propulsion Labs (JPL) presented information on the FireFly science mission. FireFly is a 3U CubeSat. The cost to develop, launch and operate Firefly for three years is expected to be less than \$1 million. This is substantially less than what would normally be expected for a mission of this type. She commented that CubeSat launches are now to the point of

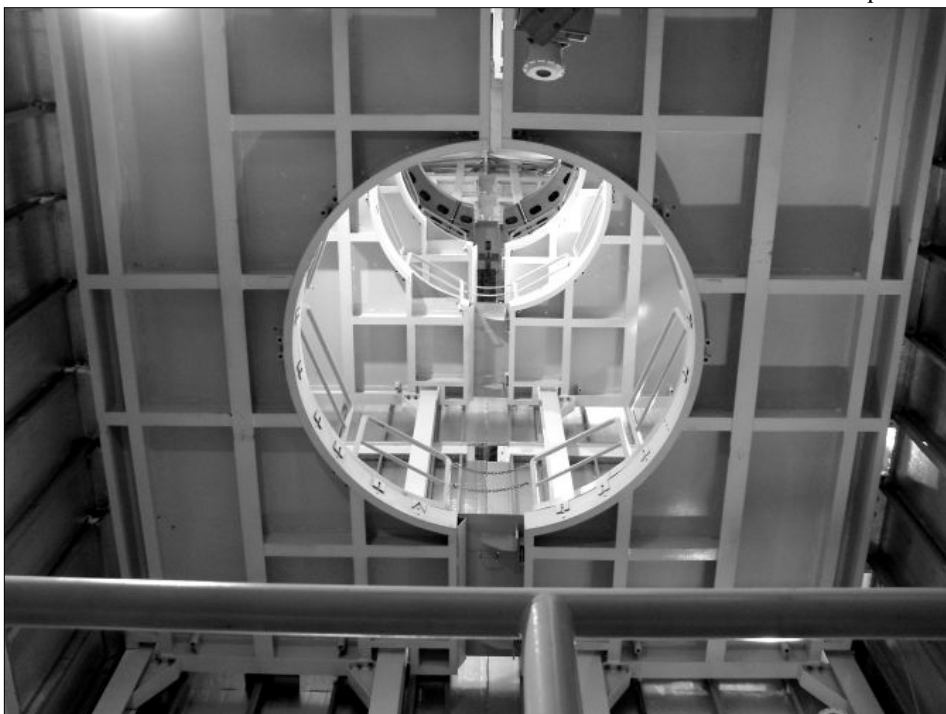


Photo 2: Interior of Service Structure.

being regularly available on an annual basis and that they expect ESPA ring launches (small secondary payloads) via the Atlas V and Delta IV to become regularly available next year. These are government-only launch vehicles.

8. Warren Frick of Orbital Sciences provided an update on small payload accommodations on their commercial launch vehicles. The Taurus XL will support CubeSats up to a 600 km, sun-synchronous orbit. Their Pegasus vehicle will also support CubeSats and the next flight in Dec 2012 will be to 620 km sun-synchronous.

9. Christian Melbostad of SpaceX provided an update on Falcon launch opportunities. He said that their upcoming ISS supply missions would be capable of deploying CubeSats. Additionally, Falcon-9 launches will be available with P-PODs to 600 km altitude in Q3 2013 and to 720 km sun-synchronous orbits in Q4 2013.

10. Jason Andrews of Space Flight Services made a presentation about their business providing “*Routine low-cost access to space.*” Space Flight Services is an affiliate of Andrews Space that provides integration and launch services for secondary payloads. They are offering “*one-stop*” shopping that makes it fast and convenient for customers needing US-based launches and they even provide pricing on their Web site with a 1U CubeSat to LEO starting at \$160K. They advertise an interesting array of launch opportunities for small satellites and CubeSats including sub-orbital, LEO, GTO and even Low Lunar Orbit launches. These prices are higher than is typical for CubeSats but they focused on certain customers (i.e. like those with 3-letter names) that require a strictly US-based launch.

11. Dan Lim of TriSept Corporation spoke about small satellite brokering. TriSept is a new company that brokers launches for secondary payloads on primary missions and provides technical services such as mission planning, operations, spacecraft development and satellite integration for a wide range of satellite sizes down to 3U CubeSats.

12. Colonel Tom Steele, Deputy Director, Office of Space Launch, moderated a panel discussion on secondary payload adapters. Many launch vehicles have excess thrust capacity, but not necessarily a place to mount additional secondary payloads. This has led to a number of projects to develop adapters



Photo 3: Launch Control Center.

to increase the vehicle capacity. The panel discussions were as follows;

Major Travis Willcox, Office of Space Launch, described a new Aft Bulkhead Carrier (ABC) for the Atlas V. The ABC can accommodate an additional volume of around 20" x 20" x 30" plus 8 P-PODS.

Garrett Skrobot, Senior Mission Manager NASA, discussed the Glory mission. The Taurus XL carrying Glory was outfitted with a P-POD to deploy three additional 1U CubeSats. These were part of NASA's Educational Launch of NanoSatellite (ELaNa) program. The launch took place March 4 of this year but the payload fairing failed to separate causing complete loss of the mission. NASA plans to fly a large number of CubeSats on future missions. So far, they have 14 slots manifested to 325 km, 13 to sun-synch orbits, 5 going to non-sun-synch LEO, 1 to GTO and 1 MEO. Garrett said NASA has found that university CubeSat projects are often late and miss their schedules. To work around this, they are intentionally over-booking these launches so that if a satellite fails to show up in time, they can just take the next one on the list and put the missing one on their list for the next launch. They want to keep their launch queue full. So far they have accepted 12 university proposals for launch.

Captain Sarah Klaeser, Office of Space Launch, discussed work on a new secondary payload adapter known as the A-Deck. The A-Deck will be compatible with ATLAS V and DELTA IV launch vehicles and

can accommodate payloads of up to 2000 pounds.

Joe Maly of Moog/CSA Engineering described work they are doing to accommodate the USAF need for rapid integration and launch of small satellites. CSA developed the ESPA ring adapters that can be used on ATLAS V and DELTA IV launch vehicles. These can carry a variety of small satellites as well as 3U and 6U CubeSat deployers. They are also developing a new adapter for low lunar orbit missions.

13. Lieutenant Colonel George Nagy, Deputy Commander of the Space Development Group at Kirtland Air Force Base, discussed the increasing need for small payload ridesharing. The cost pressures and budget cuts facing the DOD along with the need for rapid deployment of space assets will drive them toward more small satellites. One challenge to this approach is the increasing load of orbital debris tracking. He discussed ways in which small satellites could be outfitted with a simple transponder to aid in tracking them. Note that AMSAT volunteers developed the XP217 RADAR transponder experiment that was the primary mission of the RAFT/NO-60 CubeSat specifically to try this idea in orbit.

14. Kirk Woellert of Interorbital Systems described their work on new low-cost launch vehicles. They are trying to reduce costs by using lightweight composite materials and developing a cheaper rocket motor technology. Their launch vehicles will employ multiple small motors that are

individually controllable to eliminate the need for expensive and complex gimbals and the motors use parallel rather than serial staging. Their N30 first mission is scheduled for 2011 and uses 5 of these motors along with a solid fuel booster. They expect to be able to put 30 kg of payload into a 310-km polar orbit. Their goal is to get the cost of this vehicle down to \$1M. The N30 will have a capacity of 4 CubeSats and 24 of a new type of satellite they call a TubeSat. Their TubeSat kit is available for \$8K which includes the launch cost. A TubeSat is a cylindrical shape with a diameter of around 4" by 5" long for a 1U with a maximum mass of .75 kg. The launcher can accept up to a 3U TubeSat. Since the orbit has a low altitude, satellites are expected to reenter and burn up in the atmosphere within three to thirteen weeks depending on solar weather, which will safely assure orbital debris mitigation.

15. Randy Regan of NASA Langley described their work on developing a common instrument interface (CII.) The CII will make it easier to provide hosted payloads since the manufacturers of the primary spacecraft can avoid building a custom interface to the payload. The CII specification is designed for a wide variety of payload missions.

16. Aaron Roger and Clint Apland of The John Hopkins Applied Physics Laboratory, described work being done there to develop a standardized NanoSat design. The idea is to apply the CubeSat idea of reduced costs through standardization to a larger NanoSat structure. Their NanoSat would be around 16" x 16" x 22" with a maximum mass in the 30 to 50 kg range.

17. Bruce Underwood, Chief, Advanced Projects Office NASA/Wallops, described work on their 6U SmallSat project. This is project intended to decrease the cost and time needed to put a small science experiment into the upper atmosphere or even LEO by developing a standard satellite bus with standard instrument interfaces. SmallSat is based on a 6U CubeSat standard.

18. Jim Liller, Office of Space Launch moderated a "lessons learned" panel discussion on ride-sharing with representatives from The Aerospace Corporation and Ball Aerospace. All panel members had worked on the recently launched USAF/NASA STP-S26 mission. This mission included 16 science experiments and seven small satellites that were launched from the Kodiak Launch Complex in Alaska. The key

discussion issue seemed to be the difficulty and challenges of integrating all of these disparate missions. With multiple satellite providers having different requirements, processes and expectations, it is clear that they need a better process to handle it. Two specific anecdotal items were discussed. The first was that there was a need to measure the actual payload, not just review a CAD drawing to make sure it would fit since the integrator does not know if the payload meets the specifications of the drawings. The second was that minor environmental violations of the total stack may only affect limited or perhaps no payloads but without traceable requirements, it was impossible to know which ones or who to talk to. To help address these issues, they developed a detailed integration checklist of every item that needed to be completed before launch.

19. Lieutenant Colonel Taylor Locker of the USAF Space and Missile Systems Center (SMC) discussed information assurance for small satellites. Many small satellites today are being developed for classified missions. Threats to these missions can include ID theft, terrorists and hackers with the risk of releasing classified information. SMC can provide assistance in securing such mission information. It is imperative that developers of these payloads address this issue up-front so that they do not get kicked off of their launch due to security infractions.

20. Andrew Petro of NASA described their new NanoSat Launch Challenge. This challenge is to develop and demonstrate a new, low-cost launch vehicle that can put a 1U CubeSat into earth orbit and do this two times in one week. The first team to demonstrate this will win a Centennial Prize of \$2M. This is intended to spur new technology developments in low-cost launch vehicles.

The conference concluded with a tour of the Kodiak Launch Complex run by Alaska Aerospace Corporation [1]. The Kodiak Launch Complex is at Narrow Cape on Kodiak Island and is sited on 3717 acres. The launch complex includes an all-indoor, all-weather processing facility which is a good thing since the weather is often miserable! Though it is a very short flight from Anchorage, our plane was delayed for 2 hours and then required three attempts to make a successful landing on Kodiak due to the inclement weather.

The complex includes two launch pads that are fully enclosed until just a few hours

before launch, providing a comfortable work environment. Launch Pad 1, with the service structure enclosing it, can be seen in Photo 1. This pad can support vehicles up to 16 feet in diameter and includes a 75-ton bridge crane with a maximum hook height of 157 feet to allow on-site assembly of launch vehicles. The flame trench is 40 feet deep and is rated for 1.1 million pounds of thrust. The interior of the service structure is shown in Photo 2. This photo shows the view from the launch pad looking up through the service structure. A second launch pad is also available for ballistic target missiles and other small missiles that can be launched from a flat concrete pad.

The Launch Control Center provides multiple operational stations used to monitor and control the launch. A view from inside the control center during a launch activity can be seen in Photo 3 [2]. In the photo, the launch vehicle can be seen on Pad 1 with the service structure retracted and ready for launch. This center also includes a sophisticated weather station with links to National Oceanic and Atmospheric Administration (NOAA,) open-ocean weather buoys and the ability to track up to six weather balloons through 100,000 feet.

While not as glamorous as the launch pads and control center, the complex includes several other *workhorse* facilities that are needed for a successful launch: The Payload Processing Facility includes a class 10,000 clean room [3], a 15-ton bridge crane, and the capability of Hydrazine fueling operations. The Integration Processing Facility supports horizontal checking and integration of rocket motors. The Spacecraft Assemblies Transfer Facility is a building on tracks that facilitates transfer of vehicle components from the Integration Processing Facility to the launch pads. The Mobile Operations Center includes Range Safety and Telemetry Systems with dual redundant S-band and UHF radio systems plus GPS tracking capability. And finally, a maintenance and support center includes provisions for customer storage, a service bay and a machine shop.

On November 19, 2010, an Orbital Sciences Minotaur IV was successfully launched from the Kodiak Launch Complex carrying the STP-S26 mission. The STP-S26 mission was discussed during the conference (see item 18 above) and included NASA's NanoSail-D, CubeSat among many others. A video of the launch is available online [4].

Footnotes:

- [1] For more information on Alaska Aerospace Corporation, please see www.akaerospace.com
- [2] Launch Control Center photo used with permission of Alaska Aerospace Corporation
- [3] A Class 10,000 clean room has no more than 10,000 particles per cubic foot. Normal room air is around 100 times this value.
- [4] Video of STP-S26 launch from the Kodiak Launch Complex is available here: www.spaceflightnow.com/minotaur/stps26/status.html 🌐

The AMSAT Store (see www.amsat.org) is back online! Here is a new AMSAT product. A handsome and functional AMSAT 10' locking carpenter's tape with both inch and metric scales.

Minimum donation: \$5



Museum Ships Weekend 2011 – Another Successful Operating Event

by Allen F. Mattis, N5AFV, n5afv@amsat.org

The Brazos Valley Amateur Radio Club (BVARC) annual participation in the Museum Ships Weekend Event (<http://www.nj2bb.org/museum/index.html>) sponsored by the Battleship New Jersey Amateur Radio Station on June 4-5, 2011 always provides an excellent opportunity to demonstrate the OSCAR satellites and Amateur Radio. During the weekend event Amateur Radio operators activated Amateur Radio stations on 79 museum ships worldwide, down slightly from the 83 ships that participated last year. Approximately two-thirds of the museum ships were located in the United States; however, museum ships in Australia,



Photo 1: Michael Monsour, AC0TX, and Joe Wileman, AA5OP, in the USS Stewart radio room. (Photograph by Travis Burgess, K5HTB)

Austria, Canada, France, Germany, Italy, Netherlands, Norway, Portugal, Russia, Sweden and the United Kingdom also participated. Amateur Radio operators who contacted any fifteen of these ships qualified for a handsome certificate.

During the event the Brazos Valley Amateur Radio Club (BVARC) operated club station KK5W from Seawolf Park on Pelican Island in Galveston, Texas. Seawolf Park is home to two Second World War vintage museum ships - the destroyer escort USS Stewart (DE-238) and the submarine USS Cavalla



Photo 2: John Cooper, WT5Y, working the HF bands from the radio room of the USS Cavalla. (Photograph by Travis Burgess, K5HTB)

(SS-244), nicknamed the “Lucky Lady” by submariners. As a result, a contact with KK5W counted for two ships.

BVARC operated from three locations within Seawolf Park. The radio rooms on the two ships were used for operation on the HF bands using both phone and CW. The radio rooms on the ships contain a considerable amount of vintage radio gear that is no longer operational but serves as a museum display. The Amateur Radio operators brought along their own equipment but did use the long wire antennas that have been restored on both ships. A third operating location with two HF stations was set up in a picnic shelter in the park immediately adjacent to the ships. Because heavy congestion on the

satellite passes was anticipated the decision was made to work the satellite passes using an Alinco DR605 dual-band mobile radio in a vehicle from the parking lot adjacent to the picnic shelter.

The club made approximately 850 radio contacts during the event, and 33 other ships participating in the Museum Ships Weekend event were worked. A total of 37 Amateur Radio operators participated in the Seawolf Park operation.

One pass of SO-67 and two passes each of SO-50 and AO-27 were worked. A total of 41 satellite contacts were made with stations in 19 US states, Cuba and Mexico. Contacts on all three satellites were made with WD9EWK at the Show Low, Arizona hamfest. It

was nice to be able make these contacts with Patrick and to let those listening at the hamfest know that special event stations operate on the satellites.

This was the fourth year that BVARC participated in the Museum Ships Weekend Event, and the first two years KK5W was the only station worldwide in the event to operate on the satellites.



Photo 3: Picnic shelter in the park provided shade for two HF stations and attracted many park visitors providing an opportunity for them to learn about Amateur Radio. (Photograph by Travis Burgess, K5HTB)



Photo 4: Allen Mattis, N5AFV, and Carl Hacker, WC5WM, working an SO-50 pass. (Fisheye lens photograph by Travis Burgess, K5HTB)

This year we were joined on satellites by VE3RCN on the HMCS Haida in Toronto. The HMCS Haida is a Second World War Tribal class destroyer built in England and commissioned into the Royal Canadian Navy in 1943. The operators on the HMCS Haida made 9 satellite contacts and worked 7 US states, Ontario and Cuba. KK5W was not able to make a contact with VE3RCN during the Museum Ships Weekend Event and the goal of making a ship-to-ship satellite contact during the event has eluded us for another year. Perhaps AMSAT members living near some of the museum ships that participate in the event can come forward and volunteer to help to put these ships on the satellites next year.

As in past years, it was very enjoyable and rewarding to participate with the Brazos Valley Amateur Radio Club (BVARC) in the annual Museum Ships Weekend Event and we hope that other satellite operators will join us next year and participate in the event. 📡



Photo 5: Petty Officer Kevin Clements, VE3RCN, on the HMCS Haida working an SO-50 pass assisted by Bruce Dinsmore, VE3SNH. (Photograph provided by Petty Officer Kevin Clements, VE3RCN)

AMSAT is the North American distributor of SatPC32, a tracking program designed for ham satellite applications. For Windows 95, 98, NT, ME, 2000, XP, Vista, Windows 7.

Version 12.8a is compatible with Windows 7 and features enhanced support for tuning multiple radios.

Version 12.8a features:

- Select 2D/3D map with a single mouse click
- Select Political/Physical map with a single mouse click
- AOS voice announcement
- Countdown program displays next AOS of your favorite satellites
- Automatic Internet download of Keplerian elements.
- Graphical tracking on a world map with two selectable Zoom factors.
- One-click satellite switching using 12 "letter" buttons.
- Automatic rotor control support for: LVBTracker, Kansas City Tracker/Tuner, FODtrack, Uni_Trac, SatEL, Labjack U12/U3/Piggyback, W0LMD Mini/Junior/Senior Trackers, Yaesu GS-232, ARS from EA4TX, EGIS rotors, IF-100, RIF-PC, AMSAT-DL interface, WinRotor32, HalloRotor, and WiSP DDE clients.
- Doppler tuning with on-screen frequency displays. Radio models supported:
Yaesu FT-847, FT-736R, FT-817, FT-857, FT-897
ICOM IC-820H, IC-821H, IC-910H and other ICOM radios
Kenwood TS-790 and TS-2000
DDE client programs
- "Transparent" VFO-knob tuning in addition to keyboard and mouse tuning.
- "Virtual" VFO tracking for half-duplex transceivers FT-817, FT-857, FT-897, IC-706 and IC-7000.
- Includes a special version for ISS split-frequency operation.
- Controls subaudible tone on FT-847, FT-736R, FT-817/857/897, TS790A and IC-910H.
- Includes a non-graphical version and programs that output lists to the screen, printer, or a file.
- Interfaces with WiSP, with user-defined satellite switching priority.
- Includes a separate program for tracking the Sun and Moon.

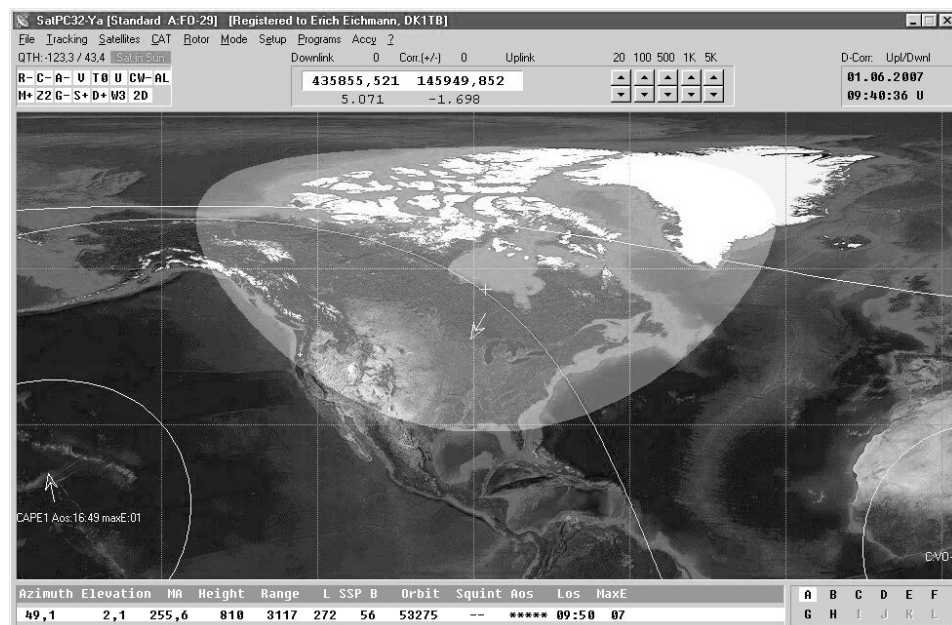
Minimum Donation is \$45 for AMSAT members, \$50 for non-members, on CD-ROM.

A demo version may be downloaded from <http://www.dk1tb.de/indexeng.htm>

A registration password for the demo version may be obtained for a minimum donation of \$40 for members and \$45 for non-members.

Order by calling 1-888-322-6728.

The author DK1TB donated SatPC32 to AMSAT. All proceeds support AMSAT.



Confessions of a Helix Junkie, Part #2

by Mike Williams, K9QHO, k9qho@arrl.net

Whether you're building a helix or Kent Britian's "Cheap LEO" for the FM birds, probably the most difficult part of any homebrew project is getting started.

How Does it Go Together?

Is it cumbersome? The satellite handbook seems to think so. It states "the main problem with using a helix is its cumbersome physical structure [1]." While this may be true for a 146 MHz helix with its 81-inch circumference and 48 inch diameter reflector, a 436 MHz build is quite manageable. When completed, a helix can be a physically strong structure. With no elements to catch or bend, it supports itself and is easily mounted onto the horizontal cross boom. The following build steps will prevent helix construction from becoming that "cumbersome physical structure [2]." This also works for a Yagi.

1. Mark and drill the boom's spreader and (if necessary) reflector locations.
2. Install a mast to boom V clamp at the boom's midpoint. (Photo #1).
3. With a short mast mounted onto a tripod or a workbench, attach boom to mast (Photo #2).
4. The spreaders are inserted horizontally, positioned, and secured. (Photo #3)

5. Wind the helix past the mast towards the reflector leaving excess helix at the receive end of the antenna.
6. Starting at the reflector, attach the helix to the "N" connector then loosely to each spreader.
7. Again starting at the reflector set the correct radius every 90 degrees then secure the helix.
8. Excess helix is removed at the receive end. Mount the helix onto the horizontal cross boom, tune, and test.

Is it Too Heavy?

At 436 and 146 MHz, the boom has the potential of becoming excessively heavy. Using large diameters of schedule 40 PVC or PVC in general for boom material at these frequencies invites weight problems. Square aluminum boom is a better choice (Photo #4). In Part One of this article, the 436 MHz helix built with 4-in. thin walled (drainage tile) PVC was an exception. The same antenna built using 1 inch square aluminum boom was much lighter with a shorter build time. At 1269 or 2401 MHz, the helix's size makes weight less of a concern. A square aluminum boom is best at 146 and 436 MHz while square aluminum or PVC will work at 1269 or 2401 MHz.

Must it be Supported in the Middle or Can it be End Mounted? Is a Counter Balance Needed?

A homebrewed 146 or 436 MHz helix is best mounted at antenna midpoint using a nonconductive cross boom. This method is much more stable than end mounting a large helix with a counterbalance. Because of size and weight, a 1269 or 2401 MHz helix may be end mounted by using the reflector or by extending the boom through the reflector. This is simpler than midpoint mounting due to the limited spacing between turns. A counterbalance will not normally be needed. But if you design an antenna system with an excessive out of balance condition (Photo #5), then a counterbalance scheme should be considered.

What are Some Tips?

RHCP/LHCP: A handheld Yagi can be positioned vertically or horizontally. A satellite cross-Yagi may have the added ability to switch circular polarization. But a helix must be built for either left-hand circular polarization (LHCP) or right hand circular polarization (RHCP). When viewing from behind the reflector, if you set up the helix conductor to rotate clockwise from the "N" connector, it will be RHCP. If you set up the helix conductor to rotate counterclockwise from the "N" connector, it will be LHCP. When AO-40 was launched, the choice was easy because the satellite's antennas were RHCP. At this time with our present group of satellites, a build at 146 MHz of LHCP and 436 through 2401 MHz of RHCP would be a good choice.

Matching: There are several methods to match a helix to 50 ohms. The two easiest to homebrew are the matching strip method [3] or one developed by VE3NPC [4]. Both methods use brass/copper shim stock or copper flashing. The strips are small and easily made for 2401 [5] and 1269 MHz. But at 436 MHz, the strip becomes sizable (6 inches) and at 144 MHz large (20 inches). The matching strip method requires a thin metal strip to be attached to the first 1/4 turn of the helix near the "N" connector. To use this method, good copper soldering practices are needed. Both parts should be cleaned, polished, and if possible, mechanically connected before soldering. Attaching the matching strip is required before the helix is installed onto the boom. VE3NPC's method



Photo 1: A mast/boom V-clamp installed opposite a spreader at the boom's midpoint.

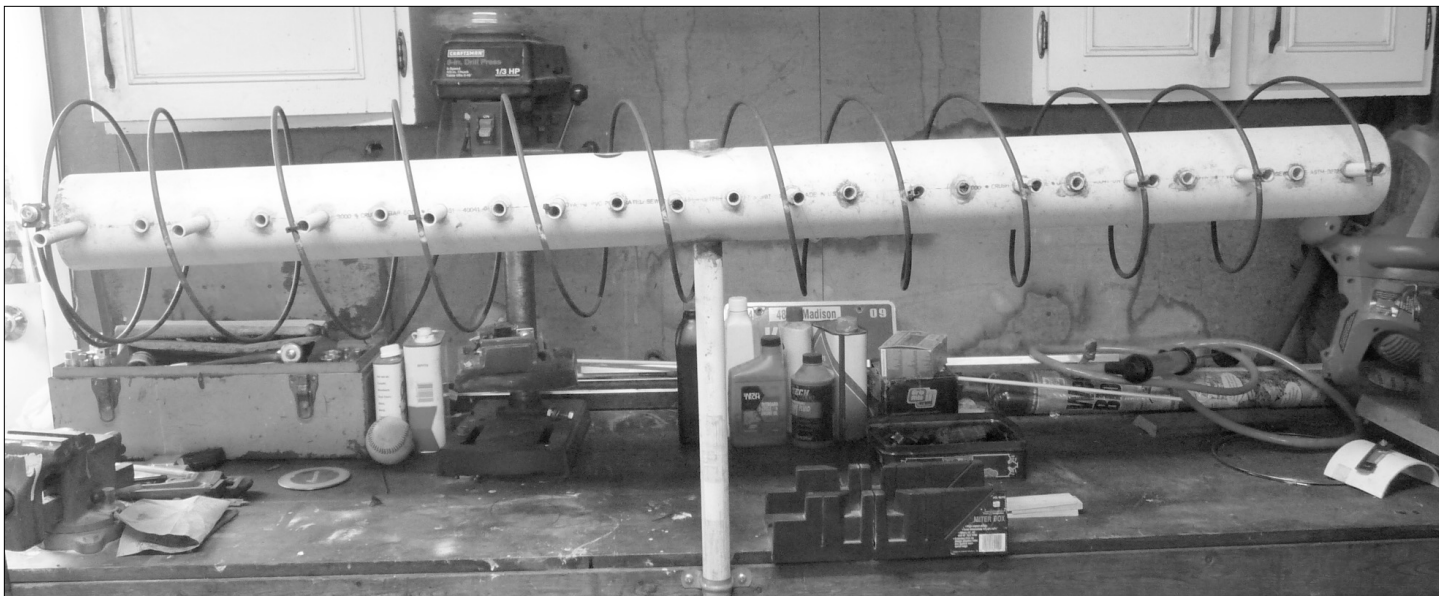


Photo 2: If you have a workbench and two conduit clamps, a short mast brings helix or Yagi building indoors for the home brewer.

moves the matching strip and the adjustment mechanics onto the reflector eliminating the need to solder to the helix conductor. Its also allows the builder to use aluminum wire for the helix. Because of the size of the 146 MHz matching strip (20 inches), the matching strip or a method similar to VK5ZAI's [6] is the least difficult. Copper tubing (1/4 inch diameter) may be flattened, the matching strip mechanically attached, then soldered. A reflector designed to slide on the boom will aid in the SWR adjustment. Sheets of copper and brass can be purchased at Hobby Lobby.

Tip: One problem facing a helix builder is setting the proper conductor radius midway

between spreaders. For 436 and 1269 MHz, doorframe shims may be used. A package costs about \$1.50. The shims are then cut to the proper radius and inserted at the 90 and 270-degree positions (Photo #6). When the correct radius is set up, the helix is secured and the shims removed.

Helix Gain: WiMo Antenna Ltd. [7] manufactures a product line of helix antennas for Amateur Radio and is sold in this country by SSB Electronic USA [8]. WiMo's catalog lists the specifications for each antenna.

Tip: To prevent UV (ultra violet) damage, all fiberglass should be painted. Masking tape should cover drilling areas to help prevent fiberglass shredding while drilling.

Tip: If 1/4 in. copper tubing is used as the conductor, it will quickly be discovered it is hard to form to a different diameter without introducing bends or kinks. The tubing may be wound on a cylinder slightly smaller than the required diameter. Insert the cylinder inside the coil and begin winding reducing the diameter to the new dimension. This method is recommended to form any conductor to a desired diameter. A short piece of #12 copper wire will connect 1/4 in. copper tubing to an "N" connector center pin.

Tip: Cable ties are the weakest part of the system no matter what type. If cable ties are used, they must be UV resistant.

PVC and Sun: PVC seems to hold up very well in sunlight. After 10 years, a replaced PVC antenna showed only weathering, copper oxidization and cable tie failure but no breakdown or cracking of the PVC. It is the builder's option to paint a PVC helix if exposed to excessive sun and heat.

A well-known homebrewer thanked me for my e-mail concerning his nice looking project and its excellent performance. He then added that in his dumpster were the remains of his unsuccessful attempts. It's important that we enjoy life and hobby.

References

- [1] *The Satellite Experimenters Handbook*, ARRL, 1983, page 6-18
- [2] *The ARRL Antenna Book*, ARRL, 19th Edition, 2000, Page 19-28/29.

Continued next page ...



Photo 3: An 8-Ft. boom with partial reflector and spreaders just installed.



- [3] The Development of a Quarter Wave Match for Helix Antennas, *The AMSAT Journal*, Nov/Dec 2005, pages 16-17.
- [4] Photos of a 2401 MHz match are at G6LVB's Web site: www.g6lvb.com/quadruple_helix.htm
- [5] VK5ZAI's 146 MHz helix is at www.electric-web.org/2m_helix_antenna.htm.
- [6] www.wimo.com, www.ssbusa.com.



Photo 4: Helix Lite: Harold, WD8RBR's, antenna uses an aluminum helix, boom and reflector.

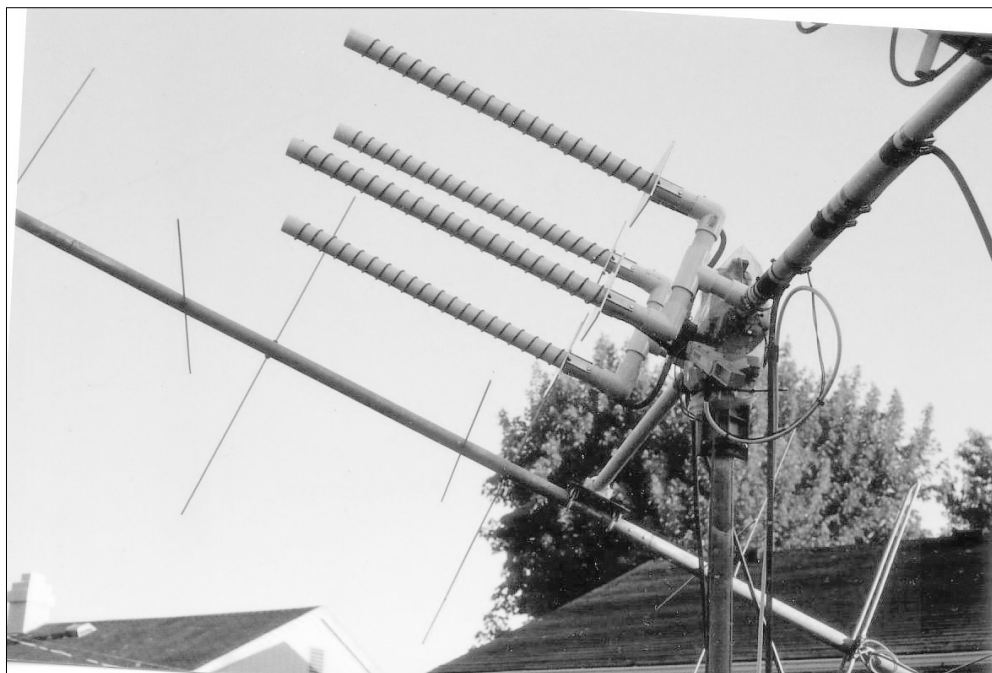


Photo 5: Is a counter balance needed?

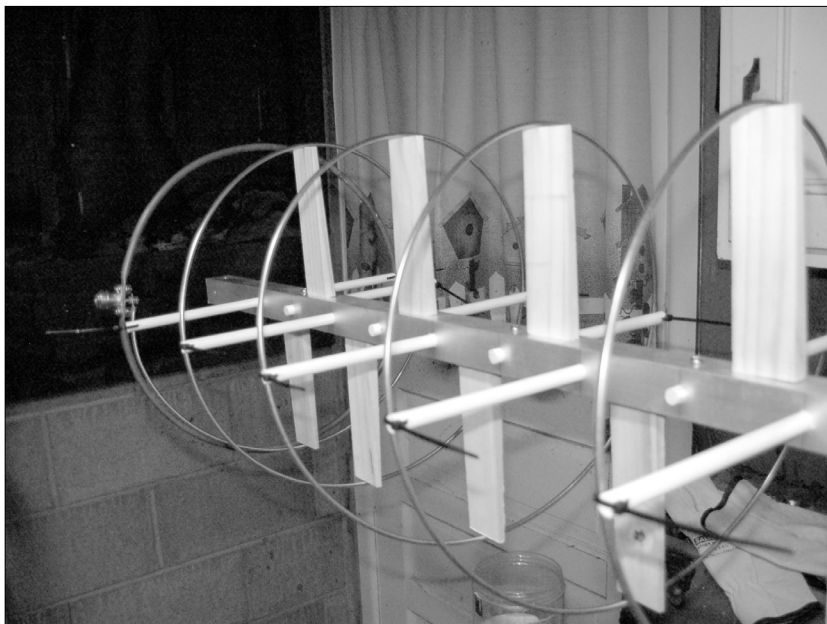


Photo 6: Door frame shims setting the radius between spreaders.



AMSAT Submits Comments on Proposed ITAR Revision

The U.S. Department of State's Directorate of Defense Trade Controls (DDTC) has proposed an amendment to the International Traffic in Arms Regulations (ITAR) updating the policy regarding defense services, clarifying the scope of activities considered as defense services, and providing definitions of various levels of defense services. As noted in the announcement that was printed in the Federal Register on April 13, 2011, "The proposed change in subpart (a) of the definition of "defense services" narrows the focus of services to furnishing of services (including training) using "other than public domain data"... Consequently, services based solely on upon the use of public domain data would not constitute defense services under this part of the definition, and therefore, would not require a license, technical assistance agreement, or manufacturing license agreement to provide to a foreign person."

The issue of public domain materials being exempt from ITAR is very important to AMSAT. AMSAT's policy has been that all technical materials developed by its' engineering team follow 'open source' policies and principles and are publicly available with the stated goal that AMSAT

will make freely available all development work performed in the design, construction and operation of technology developed for Amateur Radio satellites. A key consideration is how AMSAT can adhere to ITAR while placing its materials in the public domain. Currently, the only means recognized by the DDTC for placement of materials in the public domain is via 'paper publication', including the print publication of software. Clearly, from AMSAT's perspective, there are serious practical limitations through this sole method of making materials public domain.

AMSAT submitted comments on this proposed regulatory change on 13 JUN 11 commending the DDTC and the Administration for affirming that material in the public domain is not subject to ITAR, but noted that "Clearly then, the definition of what constitutes 'public domain' becomes of critical importance". AMSAT's formal submission to the DDTC was done through electronic mail with the understanding that its comments, along with comments submitted by other entities will be placed in the public record. As noted in AMSAT's submission, "Indeed, AMSAT finds it incongruous that the very means that DoS/DDTC has now

chosen to permit interested parties to this proceeding to respond to their request for comments and placement in the public record is not similarly recognized by the DDTC as a way originators can also place information in the public domain thereby making it exempt from ITAR."

AMSAT in its submission to DDTC "respectfully requests that the DoS/DDTC take this opportunity to not only reiterate the fact that public domain materials are exempt from ITAR, but also consider a broader definition of the recognized means of placing such materials in the public domain to also include electronic generation and distribution. Rather than focus on the METHOD for placement of materials in the public domain (e.g. paper publication), the critical criteria should be the INTENT of the originator to broadly and freely make such material available to anyone who has the ability to access it by any appropriate means."

AMSAT's formal submission to the DoS/DDTC has been posted on the AMSAT Web site and is also attached to this article below and on the following two pages. 🌐

Before the
DIRECTORATE OF DEFENSE TRADE CONTROLS
U.S. Department of State
Washington, DC 20522-0112

In the Matter of

International Traffic in Arms	)	
Regulations: Defense Services	)	RIN 1400-AC80
Proposed Rule	)	

Comments of the Radio Amateur Satellite Corporation (AMSAT)

I. Introduction

The Radio Amateur Satellite Corporation (AMSAT) was founded in 1969 as a non-profit scientific and educational organization. AMSAT is chartered in the District of Columbia and is recognized by the Internal Revenue Service as a 501(c)(3) entity. AMSAT has 3,000 members and one paid employee (our office manager). Our primary focus is the design, construction, launch and operation of amateur radio satellites that are used by amateur radio operators around the world. These satellites are licensed by the Federal Communications Commission (FCC) and are subject to the rules and regulations of the Amateur Satellite Service. Of the 3,000 members, approximately 50 volunteers are involved with various amateur satellite engineering projects.

In its 42 years of existence, AMSAT has been directly involved in the construction, testing, launch and operation of 13 satellites intended for non-commercial use by licensed radio amateurs or for educational outreach. Our most recent project, ARISSat-1, is currently on the International Space Station awaiting deployment during an EVA currently scheduled for late July.



Because ALL satellites are currently subject to the US Munitions List (including amateur radio satellites), AMSAT is registered with the Directorate of Defense Trade Controls (DDTC) as a 'Manufacturer/Exporter' and this designation is renewed annually. AMSAT last exported an amateur radio satellite for shipment to a foreign launch facility in 2004. (NASA exported ARISSat-1 to Moscow in November 2010.) In 2009, AMSAT also exported antennas to the European Space Agency for subsequent installation on the Columbus Module of the International Space Station.

There are radio amateur satellite organizations in several other countries which are similar to AMSAT. AMSAT is not able to interact with members of these counterpart organizations on not-for-profit non-commercial amateur radio satellite engineering projects because of the limitations imposed by DoS/DDTC's policy on the definition of public domain.

II. AMSAT's Perspective on 'Public Domain'

1. AMSAT respectfully offers comments on the above-cited proposed changes to the International Traffic in Arms Regulations (ITAR).

AMSAT commends the Department of State (DoS) and the Administration for their recognition that some parts of ITAR contained in 22 CFR Parts 120, 121 and 125 may have unintended consequences and for offering proposed changes to rectify such unintended consequences with respect to defense services.

2. A key proposed revision is the recognition that materials considered to be in the public domain are exempt from ITAR and that clarification is needed to more explicitly state that materials solely in the public domain are NOT considered to be a defense services. As noted in the summary of proposed changes, "Consequently, services based solely upon the use of public domain data would not constitute defense services under this part of the definition and, therefore, would not require a license, technical assistance agreement, or manufacturing license agreement to provide to a foreign person."

Clearly then, the definition of what constitutes 'public domain' becomes of critical importance. AMSAT's policy has always been that ALL technical materials developed by our engineering team follow 'open source' protocols and principles, and are publicly available with the stated goal that we will freely make available all development work performed in the design, construction, and operation of technology developed for amateur radio satellites. This policy conforms to one of the FCC's defined purposes of the amateur radio service to 'advance the state of the radio art'. Amateur Radio by definition is non-pecuniary, and we freely share our development work as much as possible as allowed by law. It is an established and accepted tradition that technical information generated for AMSAT projects is NOT restricted or licensed for a proprietary purpose.

Historically, our technical data has been distributed through a variety of means, including publication in the AMSAT Journal (primarily provided to all AMSAT members), AMSAT Space Symposium Proceedings (primarily provided to all registered participants of our annual Space Symposium), and electronic distribution via the World Wide Web without limitations, i.e no subscription, registration, password or payment is required.

3. In December 2009, AMSAT submitted to the DDTC a request for an Advisory Opinion seeking clarification of what constitutes material to be 'public domain'. We specifically requested advice on the following specific points:

- Can AMSAT presume that AMSAT technical information (disseminated by the methods described above) is largely or exclusively in the public domain?
- Is information considered to be in the public domain if it is distributed electronically to a wide and unrestricted audience?
- How would AMSAT identify exceptions, if any, to the public domain rule?

The importance of electronic distribution in today's environment cannot be overstated. The Internet has revolutionized not only the rapid and broad dissemination of information, but it has also increased the ability for collaborative relationships across broad geographic areas in the development of technical information along with the resulting sharing of the results of such collaboration in the public domain. In many instances, electronic distribution has replaced traditional 'paper publication' because of the ease, speed and lower cost of sharing such information.

For AMSAT, which has a very limited budget and is dependent upon a corps of volunteers to donate their time, talent, and energy for design and construction of our amateur radio satellites, electronic distribution is critical to our efforts. Further, given the international basis for Amateur Radio and the desire to share the development work of amateur radio satellites that benefit from such collaborative efforts, electronic distribution is an important means for sharing information that's intended to be placed in the public domain.

III. The Need to Expand What Constitutes Making Materials "Public Domain"

1. In February 2010, DDTC responded to our Advisory Opinion request, stating that the only means for making information 'public domain' was through the actual printing of such information in a publication. That is, *all* materials intended to be placed in the public domain and subject to electronic means of distribution, including the sharing of software that is intended to be public domain, must first be printed in physical form, such as a publication.

This interpretation clearly ignores the significant shift in how organizations and individuals are communicating in today's environment. These comments are being submitted to the DoS/DDTC electronically with the intent that they be made part of the public record.



Indeed, AMSAT finds it incongruous that the very means that DoS/DDTC has now chosen to permit interested parties to this proceeding to respond to their request for comments and placement in the public record is not similarly recognized by the DDTC as a way originators can also place information in the public domain thereby making it exempt from ITAR reporting requirements.

This trend towards electronic distribution will continue to accelerate, and AMSAT respectfully requests that the DoS/DDTC consider the significant changes taking place in the distribution of information, including educational materials such as training manuals, textbooks and other materials that are intended for wide distribution. Further, technical materials that are being developed under the 'open source' protocol or principles should also be considered public domain with the understanding that the originators have no intention of limiting the free distribution of their works.

2. Consequently, AMSAT respectfully requests that the DoS/DDTC take this opportunity to not only reiterate the fact that public domain materials are exempt from ITAR, but also to consider a broader definition of the recognized means of placing such materials in the public domain to also include electronic generation and distribution.

Rather than focus on the *method* for placement of materials in the public domain (e.g. paper publication), the critical criteria should be the *intent* of the originator to broadly and freely make such material available to anyone who has the ability to access it by any appropriate means.

It seems to AMSAT that electronic distribution, such as via a free and open website, constitutes placing material in the public domain more appropriately than does printing such material in a publication that requires fees to cover the costs of distribution.

Respectfully submitted,

Barry A. Baines, President
Radio Amateur Satellite Corp. (AMSAT)
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June 13, 2011





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Documentation for the LVB Tracker can be found at: <http://www.LVBTracker.com>

Boards and complete units may be ordered from the AMSAT office at 301-589-6062 or from martha@amsat.org

THE R.F. CONNECTION

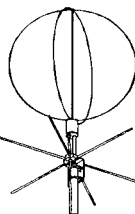
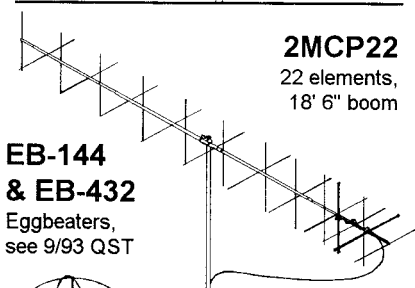
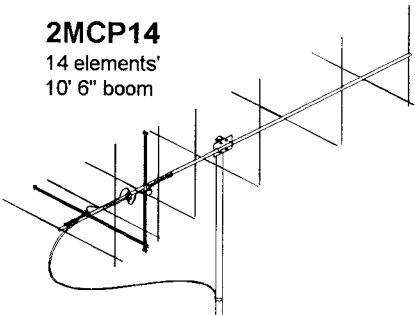
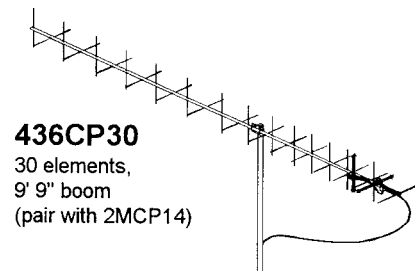
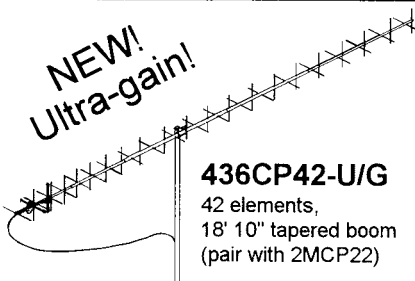
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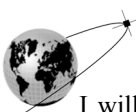
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I will not go into the details that you can read elsewhere. I was simply amazed by the depth and extent of the involvement of people interested in satellites from around the world at Hamvention. Along with the four representatives from AMSAT-China (CAMSAT), there were folks from AMSAT-Turkey (AMSAT-TR) who came back to Hamvention this year after attending their first Hamvention in 2010. Astronaut Doug Wheelock, KF5BOC, was most gracious in talking with amateurs, signing autographs at both the ARRL and AMSAT booths on Friday and Saturday, and making spontaneous remarks to the attendees of the AMSAT-TAPR dinner on Friday night. The CAMSAT folks made several contacts on VO-52 and FO-29 when they visited the AMSAT satellite station located outside the Ballarena entrance. AMSAT-UK member Howard Long, G6LVB, visited the AMSAT booth and was available to answer questions about the FUNCube Dongle (FCB), a SDR device that offers significant potential as a satellite receiver.

AMSAT Engineering had plenty to show at this year's Hamvention. The ARISSat-1 prototype was on display. Alex Harvilchuck, N3NP, spent time at the booth explaining the engineering work on the Next Gen

CubeSat being done by students at SUNY-Binghamton. This development work is the students' senior project and is a continuation of a cooperative effort between AMSAT and IBM/SUNY-Binghamton.

Basic information on Project Fox was also shown.

I will also note the extensive amount of preparation that goes into AMSAT's participation at Dayton. Two key individuals are Gould Smith, WA4SXM, and Martha Saragovitz, AMSAT's manager. Gould has been leading AMSAT's participation at Hamvention since 2005 and his thorough knowledge and preparation shows in the quality of AMSAT's booth and the efficiency of the operation. Gould also coordinates AMSAT's participation in the joint AMSAT-TAPR Friday night dinner. On top of everything else, Gould updates his book, *Amateur Radio Satellites* each year for Dayton and this year was no exception. During the weekend, Gould rarely leaves the booth, devoting each minute of the Hamvention to managing our booth.

Gould works with Martha Saragovitz, AMSAT's manager, on the myriad of details leading up to Dayton. The materials that AMSAT offers (shirts, hats, trinkets, software, etc.) are coordinated by Martha,

who also handles memberships and software registration at the booth. Nothing gets by these two individuals!

The AMSAT Forum this year was outstanding and thanks are extended to Alan Biddle, WA4SCA, for serving as our moderator. Alan coordinated the scheduling of presenters, made sure that speakers kept within their allocated times, and coordinated with the Hamvention Forum Chair on the details of AMSAT's Forum.

If you've never been to Dayton, please consider coming at least once. It is the largest Amateur Radio gathering in North America with 20,000+ plus attending and hundreds of vendors and manufacturers represented. There is nothing else quite like it.

AMSAT Symposium

It isn't too soon to start thinking about attending the 2011 AMSAT Symposium. This year's event will take place in San Jose, CA the weekend of November 4, 2011 at the Wyndham Hotel. Herb Sullivan, K6QXB, is the chairman of the event. Given that 2011 is the 50th Anniversary of the deployment of OSCAR-1 and that the satellite was built in California under the auspices of Project OSCAR, we look forward to celebrating this significant milestone for Amateur Radio in space during Symposium. 🌐



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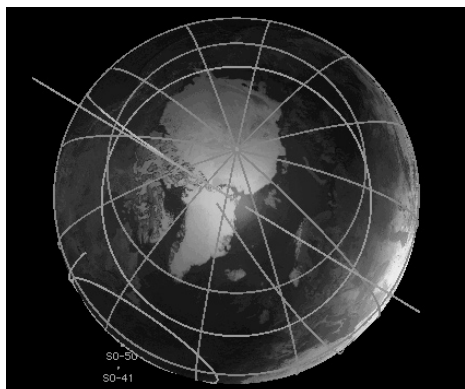
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- Video recording, digital conversion and editing
- Write technical or instructional material
- Educational activities
- Promoting AMSAT as an Area Coordinator



and any other area you think you think you can make a difference.

We often have people volunteer, but many don't deliver on their promises. So, pick an area that you think needs improvement and explain what you will do to make it better. Then do something to show that you can follow through.

Send your suggestions, actions plans and a description of why you are capable of doing this task to Gould Smith, WA4SXM, wa4sxm@amsat.org



2011 Field Day Results by Bruce Paige, KK5DO, kk5do@amsat.org

Another year, another Field Day and again more fun in the sun (or rain). We had a slight decrease in stations, but a large increase in the number of QSO's this year (455 total in Table 2). AO-7 phone had the most QSO's followed by VO-52 phone and FO-29. This was completely different from the most active satellites last year. I determine the number of satellites by mode. Thus, VO-52 in voice and CW would make two satellites. You can see from

W5MSQ, with a total of 92 points, 14 point more points than last year's total.

Holding on to second place for four years is the Lafayette DX Association, W9LDX, with 77 points, 7 points more than last year's total. But, we are not finished. Tied with the Lafayette DX Association for second place this year is a new comer, the Stanford University Amateur Radio Club, operating as W6YX.

Knocking the Huntsville Amateur Radio Club, K4BFT, out of third place is the San Lorenzo Valley Amateur Radio Club operating as K6MMM with 48 points.

Our top home station running on commercial power was Jerry, K5OE, with 34 points. I have to make a funny here. In the past, Jerry has overlooked sending in his entry on time and when this year's entry arrived shortly after the end of Field Day, I had to drop him a note back saying, "Don't want to miss the deadline?" to which he replied, "You have a mind like a steel trap."

There were 6 satellites used this year with a total of 335 QSO's, down from last year's 387 QSO's. This year AO-7 carried most of the QSO's with 109 phone and 6 CW, VO-52 with 78 phone and 5 CW while FO-29 carried 64 phone and 5 CW. On the FM satellites, AO-51 carried 10 QSO's. Out of the 14 stations operating, only K5OE, W9LDX and W6YX operated all three of the FM satellites.

The United Radio Amateur Club, operating as K6AA, was comfortable in this tent with their antennas right outside (Photo1). In Photo 2 notice the flamingos keeping the generator company?

Up in Canada, Keith, KB1SF/VA3KSF, said that this was their club's first ever Field Day. We have to include a couple of pictures of their Field Day site.



Photo 1: The United Radio Club, K6AA, with their tent and antennas.

Table 1 that we had four fewer satellites to use this year than in 2010. The interesting thing is that fewer stations participated this year and the scores were much better than previous years.

Every year the question is, and this is the best part of the article, who took the top honors? Here is what you have been waiting for and the results are a bit interesting. The number one station in the emergency power category is the Houston MosQRPitos, using the call

Table 1				
	2008	2009	2010	2011
Satellites	8	12	13	9
QSO's	220	328	387	335
Stations	17	20	18	14



Photo 2: K6AA used some pink flamingos for some reason - well we're not sure why

The Lambton County Radio Club operated as VE3SAR. In Photo 3 are, from left to right, Rick, VE3RYK (Club President); Bob, VE3RSI; Chet, VE3CFK and Art, VE3GNF.

In Photo 4 Keith, KB1SF, makes a contact. Photo 5 shows the Lockheed Martin ARC, operating as W5IU, setting up. For camping, they had it made in the shade. However, Keith, W5IU, said that they made a critical error this year, "We also set up in the middle of a bunch of large trees. We had a fairly large "hole" overhead but a lot of blockage at low elevations. Needless to say, we suffered from "ERP Withdrawal" on the FM birds and to some degree on all birds."

Photo 6 shows the operators of the Lafayette DX Association, W9LDX, knocking out another contact. Steve, N9IP, pointed out this year, "We missed not having HO-68 this year and listened without luck for the ISS. Can't say if they weren't there or if we had old Keps." No, we did not have the ISS active they did not miss an extra contact.

And finally, we will end our story with a couple of pictures from the winning club, the Houston MosQRPitos, operating as W5MSQ. Powering their entire Field Day site was this 10 kW lemon? (Photo 7) Well, it kept the clock going.

And what would Texas be without some really good BBQ? I mean really fresh, right

off the hoof. You can see Andy, W5ACM's car and the Field Day satellite antennas just to the left of the Bar-B-Q on the hoof. Photo 8.

Next year, as I have said many, many years before, I hope that we have even more participants in the AMSAT Field Day. Hopefully, Murphy will not visit your Field Day site. But if he does, be prepared.

Finally, Table 2 ranks by number of QSOs all of the entries received is on the next page. In the case of a tie, the call signs are listed alphabetically.

73 and Good DX

Bruce, KK5DO ☸



Photo 3: Members of the Lambton County Radio Club operated as VE3SAR.



Photo 4: Keith, KB1SF, makes a contact.



Photo 5: The Lockheed Martin Radio Club sets up in the shade of a number of trees that didn't help their signals up to the satellites!



Photo 6: Lafayette DX Association making QSO's.

Photos continue on next page ...





Photo 7: The Houston MosQRPitos brought along a lemon to power their clock.



Photo 8: The MosQRPitos had some roving Bar-B-Q to deal with.

Table 2			
Rank	Call	QSO's	Category
1	W5MSQ	92	2A Emergency
2	W6YX	77	1F Emergency
3	W9LDX	77	1A Emergency
4	K6MMM	48	4A Emergency
5	K6AA	45	4A Emergency
6	K5OE	34	1D Commercial
7	K4BFT	29	4A Emergency
8	W5IU	15	3A Emergency
9	W5RRR	12	2D Commercial
10	VE3SAR	10	3A Emergency
11	K9MOT	9	1A Emergency
12	KO6TH	3	1D Commercial
13	WD9EWK	3	1B Emergency
14	N5BB	1	3A Emergency
Total QSO's		455	

GENSO – A Ground Station is a Terrible Thing to Wasteby Craig Kief, KE5VSH, craig.kief@cosmiac.org

The average AMSAT ground station operator uses his or her equipment a limited number of hours each day. Once their spouses yell at them they power down and go become part of the family again. We would ask instead that you consider leaving that equipment on and join a rapidly growing community working on GENSO. The Global Educational Network for Satellite Operations (GENSO) system is a software networking standard which allows a user to communicate with a spacecraft by using a remote ground station which has a clear view of the spacecraft. Communications between the client computer (a mission control computer) and the ground station server (your groundstation computer) are conducted across the Internet.

There are three major components to the GENSO system

- **GSS** – The Ground Station Server is the ground station like mine here in Albuquerque. During the days I often do research and other “fun” things with my ham equipment. When I get ready to go home for the evening, I switch on GENSO. Until I come in the next day, my ground station is actively working tracking low earth orbit satellites and downloading AX.25 packets.
- **MCC** – The Mission Control Client is the control station for a satellite. Each satellite will have one MCC. A GSS will see a snapshot of the satellite but only MCC will have the entire picture.
- **AUS** – The Authentication Server is the server that mediates communication between MCCs and GSSs on the

GENSO network. When a ground station wants to join the network, the AUS permits them and then assigns them bookings to accomplish. The current AUS is located in Vigo, Spain and the backup is at Cal Poly: San Luis Obispo.

One of the major factors driving programs such as GENSO is something called a CubeSat. These small satellites are about the size of a standard coffee cup box. NASA has recently announced that under their Educational Launch of Nanosatellites (ELaNa) program that they will be launching more than 20 of these educational satellites in the next two years. These satellites often operate in the UHF and VHF bands. Many of these satellites are often placed in very low orbits (<340 Km) with mission lives of less than six months. For these, the average ground station can see a satellite for 10-20 minutes, 4-5 times a day. Many of these satellites are almost constantly transmitting health and status information via AX.25 packets.

My ground station is representative of a typical GSS. There are also three main components that the GENSO system remotely controls:

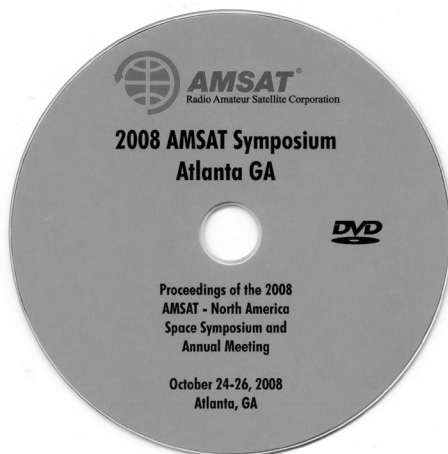
- **Rotator Controller** – I have my 2 meter and 70 centimeter antennas being controlled via a Yaesu GS-232B controller.
- **TNC** – I use a Kantronics KPC3+ to modulate and demodulate my AX.25 packets.
- **Radio Controller** – I use a CT-17 to remotely control my ICOM IC-910 radio.

To run these three devices, I connect them with serial cable to my 4-year old Windows PC. The GENSO software is written in Java. GENSO was developed and is currently maintained under the auspices of the European Space Agency. GENSO is currently running under release RIE. Version R2 should become available in 2011.

The critical need right now for GENSO is for ground stations and developers. The beauty of GENSO is that any hardware can be utilized to perform the three functions listed above. The downside is that there are very few drivers currently developed. If your ground station looks like mine, we could bring you into the GENSO family very quickly. As an educational institution (University of New Mexico) that is building a CubeSat to launch later this year, I can tell you that you would have the undying gratitude of all of us small satellite folks.

If your ground station isn't configured like mine, that is still interesting. In that case we would like to talk to you about developing Java drivers for the equipment you have so that we can continue to grow the GENSO library of available modules.

If you would like more information about GENSO please consider attending the August CubeSat workshops (www.cubesat.org) or contact Craig Kief at craig.kief@cosmiac.org or Connor Lange at reclange@calpoly.edu. ☺



2008 Proceedings DVD's are available. Contact the AMSAT Office.

A DVD for the 2008 Symposium is available.

It has the presentations, audio files and papers.

Dan Schultz's Banquet Talk on The Hubble Space Telescope Repair Mission - slides and audio

Phil Hartman's Introduction to DSP Workshop - slides and audio plus

2004 Symposium papers

2005 Symposium papers

2007 Symposium papers



Moonbounce from the Bottom Up

by Bob DeVarney, W1ICW, w1icw@myfairpoint.net

The year 2010 marks my 30th year as an Amateur Radio operator. That is nearly 3/4 of my life! To celebrate, this year I decided to do something REALLY different. I have always been known for pushing myself by trying out different aspects of the hobby ... everything from QRP to satellite operating. I love a good technical challenge. I also like to do things that nobody else in my area is doing. This time around I really wanted to combine Amateur Radio with another of my recent hobbies, metalworking.

my Kenwood TS-2000X. A little bit of level setting and debugging later I was ready to try. I anxiously awaited the next moonrise. Once the moon cleared the horizon, I trained my satellite Yagi on it, and started trying to decode a signal ... ANY signal. After some initial fumbling, I managed to decode Anatoly, RK3FG, and I tried transmitting. I won't say it was an immediate success, but I did eventually manage to work him! I had my first EME QSO in the log, and I was HOOKED! I continued to work more stations in the coming weeks and months,

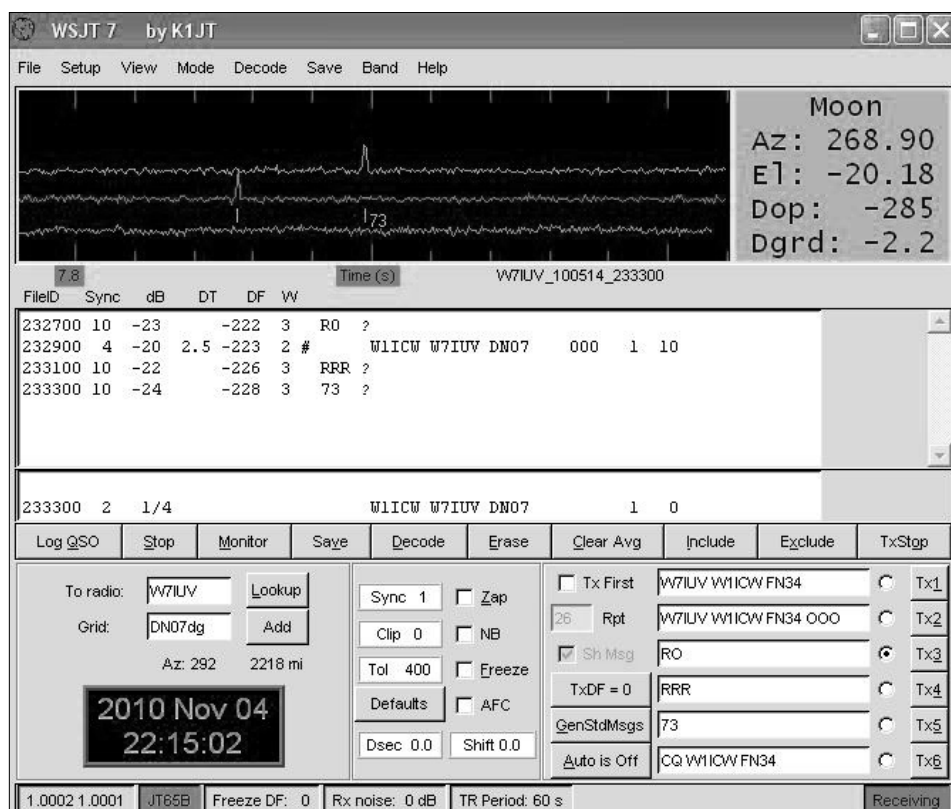
combiner, phasing cables, transverter, and the support structure.

I wanted to assemble the entire station as inexpensively as possible. I wanted the project to be a zero-cost affair, so several items of surplus gear were sold off to help fund it. To date, I am actually still right on track on my balance sheet. I was extremely fortunate to have 110 feet of 7/8 inch hardline and connectors donated by my favorite antenna crew (I work for a large wireless communications company), which would have seriously dented the budget. Still, it eats up a surprising amount of money to put together a complete station ... rotors, antennas, rotor cable, feedline - never mind the amplifier and the rig. I already had a 2 meter all-mode rig in my Kenwood TS-2000X, but chose to go with an Elecraft XV-144 transverter for the EME station rig because it gave me an excuse to buy one and build it. I already had a well optioned Elecraft K2, so I was set for an IF rig.

On the power front, I kept on the lookout for a 300 watt class 2 meter amplifier. Since JT65 does not require a linear amplifier, that broadened the choice considerably. I finally found a Vocomm Class C repeater amplifier for around \$350 and purchased an IOTA 55 amp 12 volt switching power supply for another \$200. This would give me 300 watts out with 7 watts drive (nicely within the output level of the Elecraft transverter). The Elecraft transverter, transverter interface and assorted upgrades to my early model K2 were just under \$500.

Next I had to have a way of pointing the antennas. I located a Yaesu G800 azimuth rotor on a well known online auction site for \$200. The elevation rotor was a tougher nut to crack. I had toyed with the option of a Yaesu 5400 or 5500 az/el but ruled them out as too expensive. Used, they were pure unobtainium. I finally had to bite the bullet and purchase a new G-550 elevation rotor. Combined price was around \$600 for both rotors, and about \$125 off the cost of a new G-5500. The used G800 rotor was disassembled, checked and the bearings repacked with low temperature snowmobile grease.

Antennas took a lot of thought and consideration. I wanted an array large enough to allow me to regularly work stations, but small enough not to overwhelm the modest



WSJT main screen.

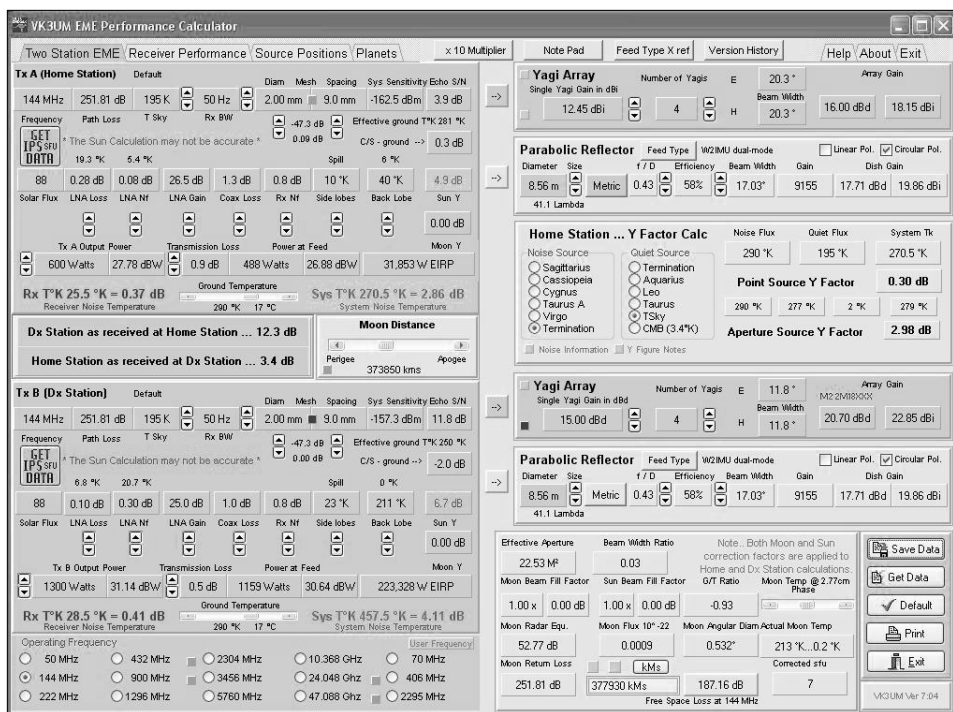
I chose to try moonbounce. I had read with great interest about moonbounce operating, and was intrigued. But frankly, the prospect of putting up an antenna array with as much aluminum as a modern passenger jet put me off a bit. Then a few years ago, I read about WSJT by Joe Taylor, and how the software had revolutionized weak signal operating. The fact that EME could be done with a 100 watt single Yagi station was stored in the back of my head for later reference. I HAD a single Yagi and 100 watts!

I decided to try this out for myself in mid January. I downloaded the software, and dug out the homebrew Rigblaster™ I had built for

but NONE of them came easy. I had a LOT to learn!

I set a goal for myself to assemble a modest EME station capable of regularly making contacts relatively painlessly. I wanted to prove to myself that moonbounce contacts could be made with a station that didn't take up as much real estate as Rhode Island, nor cost as much as the GDP of a third world country. I wanted to make as much of it as possible from scratch, within reason, both for cost savings, and for the sheer fun of making it. I chose not to homebrew the antennas for simplicity's sake. I figured I would have my hands full making the H frame, 4 port





VK3UM's EME Performance Calculator main screen.

rotors or the homebrew support mast I had planned. I know of at least one former EME operator here in Vermont who gave up the battle of keeping a large moonbounce array aloft in Vermont winter ice storms. Another advantage of a smaller array is a broader beamwidth, thereby reducing the pointing accuracy requirements. I read all I could find on the subject, especially a blurb on the Directive Systems Web site about the KC4/W1MRQ operation in Antarctica. I figured if an array of 4 shorter antennas could survive at the South Pole, then it would probably be more than adequate for me. Ultimately the M2 2M7 was chosen due to its compact size, decent performance and reasonable price. I ordered four of them and assembled and adjusted them once they arrived. Chalk up another \$650 or so to the balance sheet, and some more surplus gear went up for sale.

The final installment was the assorted rotor cable, stainless U-bolts, 1 1/2 inch thick wall aluminum tubing for the H frame, preamp and other various and sundry bits and pieces of hardware, including a 21 foot piece of 2 inch galvanized steel pipe I used for the support mast. So far, slightly over \$2300 spent total. Again, I list these costs to illustrate that EME is not outside of the realm of possibility for the average ham, even in these tough economic times. If things are purchased in a piecemeal fashion as I have done, a full station can be assembled for a minimum of pain and suffering.

I assembled the H frame for the antennas out

of 6061-T6 thick wall 1 1/2 inch aluminum tubing. Plenty rugged, light and I was able to purchase the aluminum locally from a machine shop in 24 foot lengths and cut them down to length myself for far less than ordering online and shipping. The cross brackets were made in the home metal shop from 6061-T6 1/4 inch thick aluminum and drilled all at the same time, so I knew the holes would all line up. Similarly, a 4 port power divider was made out of 3/8 copper pipe, 1 inch aluminum box tubing and 5 N connectors. All the connectors were mounted with stainless hardware and then the hardware was covered with JB-Weld epoxy to render them waterproof.

The support structure is a piece of 2 inch OD galvanized steel water pipe, also purchased locally. Since I had no way to transport the 21 foot length, the sprinkler company I purchased it from was nice enough to deliver the pipe to my house on one of their trips to a nearby jobsite. I made brackets to mount this to a pole barn on my property. The brackets were made such that I could tilt the array over using a small boat winch for easy assembly or maintenance, since I am not, nor ever have been, a heights person. The array can be tilted over safely by one person in a couple minutes. A 12 inch square metal box was scrounged to mount the relays and preamp in at the bottom of the mast, and all the feedlines were run to the pole barn from the operating position inside 4 inch irrigation tubing buried underground.

The array is compact: roughly a box 8 foot square. The antennas have 8 foot booms, and the spacing dimension is roughly 7 feet, so it makes for a short, boxy array. The M² Web site shows a similar array, albeit with closer spacing, in the pickup bed of a small truck as a VHF rover setup.

Now is a good time to take a step back from discussing hardware to look at software. First and foremost of course is Joe Taylor's WSJT. This program has done much to put EME within the grasp of the average ham. And the best part is the cost ... ZERO. Joe's excellent software has already been discussed in the pages of QST and I will not attempt to explain its operation here.

During the planning phase, it can be helpful to try out antennas, power amplifiers and potential preamps out, preferably without actually paying for them. A good computer simulation is needed, and this is exactly what VK3UM's EME Calc software delivers. I have spent countless hours poring over the calculator software trying out different ideas and calculating what the impact will be for me. In the process I have saved a lot of money and frustration by discarding designs that didn't pan out. Doug has also written a nice EME scheduler software program to help you plan when would be the most opportune time for a mutual schedule with a DX station. Another excellent planner is GM4JJJ's MoonSked. This is the one I use more often than not. So far, all the software has been free. I will not go into the actual use of the software here; that is an entire article unto itself.

Another article could be written on the vagaries of EME "propagation" encompassing such arcane topics as libration fading, Dpol, Faraday rotation and degrade. After almost 10 months of operating and nearly nightly research, I still have a long way to go to completely understand some of these. Already, knowing what I now know, I am amazed that I made some of my early contacts. It has been fun to go back with MoonSked and see what the conditions were like when I made some of my early QSOs. To say that the stations on the other end of these QSOs had to work would probably be an understatement.

Degrade is a number, expressed in dB, of the degrading effects of two very different things: the background cosmic noise behind the moon that can mask the infinitesimally small echoes we are trying to copy, added to the additional loss from the slightly eccentric



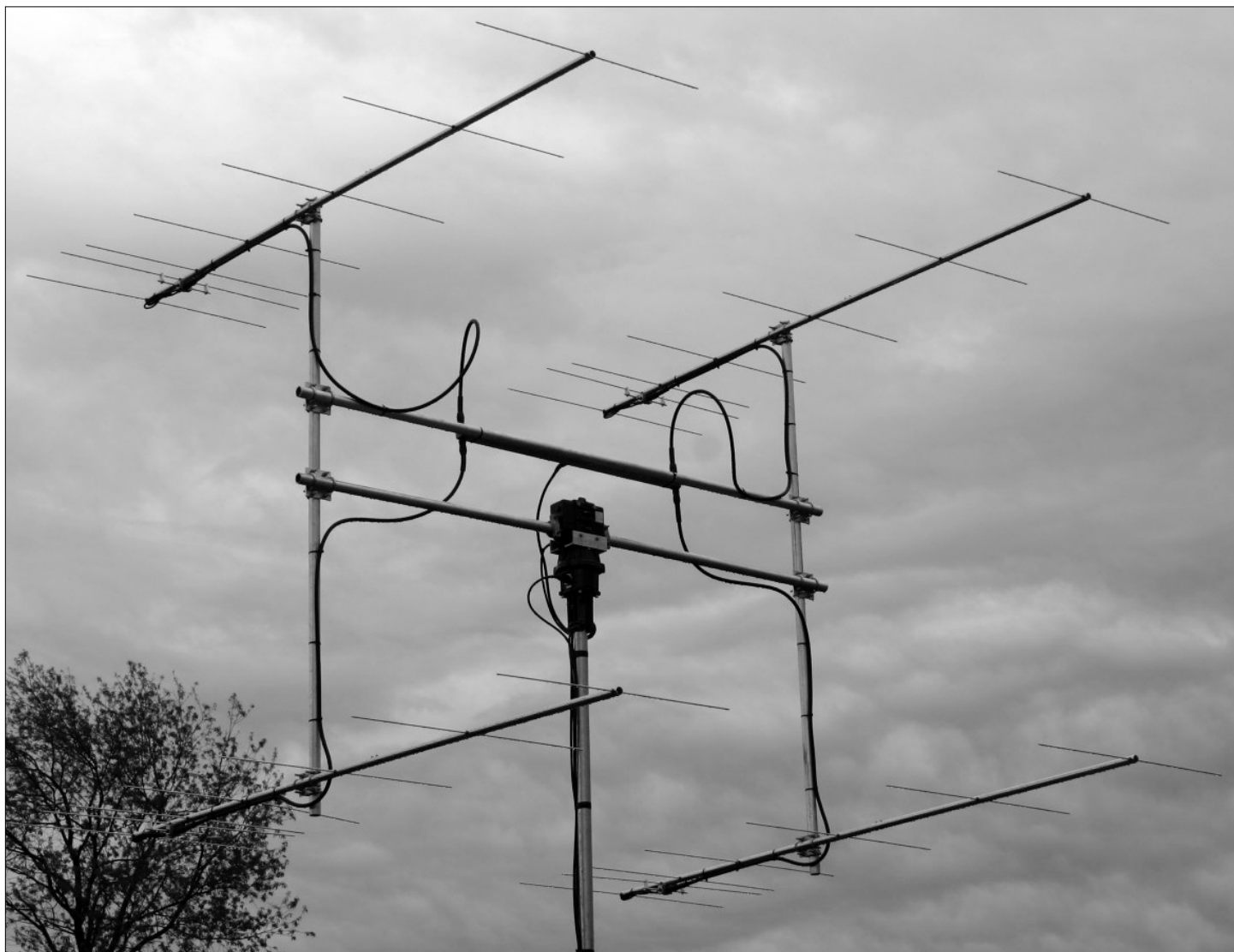
orbit of the moon (the orbit of the moon is slightly elliptical, not circular)

Nearly every part of the sky has some inherent cosmic noise from the explosion of stars. This background can be fairly minimal, or quite active. The actual degrade number on 2 meters can go from a low of around zero dB to well over 10 dB within the same month. The sun itself is a huge noise source on 2 meters and can contribute at least another 3 dB or more of noise of degrade, if it is within the beamwidth of your antenna array. This is one time when having a broad beamwidth is not quite so beneficial! When you are a station that is already operating on the edge of things, it is important to choose the best times of the month to operate. These are published monthly in several V/UHF magazines, are available online (just Google EME calendar) and can be predicted by all of the programs previously listed.

The larger an EME station is, the less that station is affected by these factors. Hence more of the month can be utilized. Life is about tradeoffs. In the sales business where I work this would be called a “good price point”. To make a significant improvement to my station would also take a significant amount of investment. For the time being, I am very satisfied with my results. I will not attempt to discuss Dpol, Faraday rotation, or libration fading, because they really wouldn’t add much. Suffice it to say that looking them up on the Internet will give you lots of reading material.

In the final tally as of April 3, 2011, I stand at 201 EME QSOs with stations in 27 states and 39 DXCC entities. I have worked 131 grid squares and qualify for a 2 meter WAC award. All but 10 of these contacts have been made since erection of the new array in mid May 2011, so I think that is a very

good tally for only 6 months of operating. Of the 201 QSOs, I have worked 163 discrete stations, so there have been some duplicates, particularly since I worked both weekends of the ARRL EME contest. I have had an enormous amount of fun and learned a lot along the way. By all accounts, my experiment has been hugely successful, and I stand poised for a coming winter of more EME fun. 🌐



W1ICW's EME antenna array.

AO-51 Operations Update

AMSAT Vice-President of Operations Drew Glasbrenner, KO4MA, provided the latest details in AMSAT's work to keep AO-51 operational for as long as possible.

Drew wrote, "Keeping AO-51 operating requires the US command team routinely restarting the satellite, and tweaking the power settings to find a combination of operating parameters to get it through eclipse. Currently one of the 6 battery cells onboard is shorted, and another is in really poor shape."

Continuing, Drew explains, "The onboard computer was crashing each orbit because of low voltage when the solar cells were no longer receiving illumination and the satellite relies entirely on its internal battery power. Through experimentation the Command Team seems to have found a balance point where it will sometimes go up to two days before crashing."

Each time the computer crashes the Command Team has to restart it using the housekeeping software onboard in ROM. The firmware code has a limited functionality compared to the normal flight software which we would upload from the ground over a few days time. However the eclipses and battery problem were causing a crash before the upload can complete.

Drew concludes, "With lots of luck we will be able to continue to limp along. How long is anyone's guess. I'd encourage you to use AO-51 while it's available, and to financially support new satellite programs like Kiwisat, Funcube, and Fox when you can."

Uplink: 145.880 MHz, no tone.

Downlink: 435.150 MHz

The repeater is open to all when the satellite is operational.

Keep up with the latest AO-51 Control Team News on-line at: <http://www.amsat.org/amsat-new/echo/CTNews.php>

[ANS thanks AMSAT-NA VP Operations Drew Glasbrenner, KO4MA for the above information]

2011 AMSAT Space Symposium First Call for Papers

This is the first call for papers for the 2011 AMSAT Space Symposium to be held Friday, November 4th through Sunday,

November 6th at the Wyndham San Jose Hotel, San Jose, California.

Proposals for papers, symposium presentations and poster presentations are invited on any topic of interest to the amateur satellite community.

We request a tentative title of your presentation as soon as possible, with final copy submitted by October 1, 2011 for inclusion in the printed proceedings.

Abstracts and papers should be sent to Dan Schultz, N8FGV, at: n8fgv@amsat.org.

[ANS thanks Dan Schultz, N8FGV for the above information]

2011 AMSAT Symposium and Annual Meeting

AMSAT announces the 2011 AMSAT Space Symposium will be held on Friday, November 4th through Sunday, November 6th in San Jose, CA. This annual gathering will feature:

- Space Symposium with Amateur Satellite Presentations
- Operating Techniques, News, & Plans from the Amateur Satellite World
- Board of Directors Meeting open to AMSAT members (Nov. 3-4)
- Meet Board Members and Officers
- Annual General Membership Meeting
- Annual Banquet-Keynote Speaker and Door Prizes

The 2011 Symposium hotel and registration web pages are now available on the AMSAT Web site. You may register for the Symposium and Annual Banquet at the AMSAT Store: <http://www.amsat-na.com/store/SymposiumReg.php>

The hotel selected is the Wyndham San Jose, close to the airport. The AMSAT discount rate is \$79.00 + taxes per night. The reservation block code when calling the hotel directly is "AMSAT". The hotel telephone number is 408-453-6200. If you are making reservations on-line use 1031FSJAM for the group code. The direct link to the hotel Web page is: <http://www.wyndham.com/hotels/SJCAP/main.wnt>

Additional information about the 2011 AMSAT Symposium will be posted on the AMSAT Web site as it becomes available.

[ANS thanks the 2011 Symposium Committee for the above information]

Announcing AMSAT Project FOX Web Site

Alan Biddle, WA4SCA, is pleased to announce that AMSAT's Project FOX Web site has been updated. Titled, "Introducing FOX, AMSAT-NA's NextSatellite!", this page brings you the highlights of:

- "Why do we need Fox?"
- A link to the Project FOX presentation of slides from the Dayton AMSAT Forum
- A Project FOX donation widget
- FOX Project Status
- High level project design goals
- A call for volunteers to join the AMSAT FOX Team

Begin your exploration of the AMSAT FOX project at: <http://www.amsat.org/amsat-new/fox/>

Here is a summary of AMSAT Project FOX design goals:

Development Phase: Approved by the Board of Directors. Design in progress.

Projected Launch: 2013.

Spaceframe Structure: Standard 1U (One Unit) CubeSat.

Spaceframe Size: 10cm X 10cm X 10cm.

Mass: Approximately 1.33 kg, ~ 3 lbs.

Orbit: 600 - 800 km, circular, depending on launcher.

RF: 500 mW EIRP, U/V (Mode B). Deployable antennas.

Transponder: High density Software Defined Transponder (SDX).

Power source: Deployable solar arrays. Lithium Ion or NiCd batteries.

Power management: Maximum Power Point Trackers.

[ANS thanks Alan Biddle, WA4SCA for the above information]



The perfect combo, without compromise.

HF/6m/2m/70cm/23cm¹ Transceiver

IC-9100

For years, the attention to receiver design focused on the HF bands, leaving the upper bands a bit neglected. Icom changed the ham world with the introduction of the IC-7800, which incorporated a new front-end design just for 6m. Now, Icom introduces the IC-9100, extending the latest in front-end technology up to more of the VHF/UHF bands. 2m, 70cm, and 23cm¹ enthusiasts can now benefit from high-end IF-DSP performance too!



100/100/100/75/10¹ Watt Output²

AM, FM, SSB, RTTY, CW, & DV¹

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Type B USB for Rig Control and Audio



Shown with optional desktop microphone SM-30 and additional third party accessories. ¹Optional unit required. ²See manual for AM output power.
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